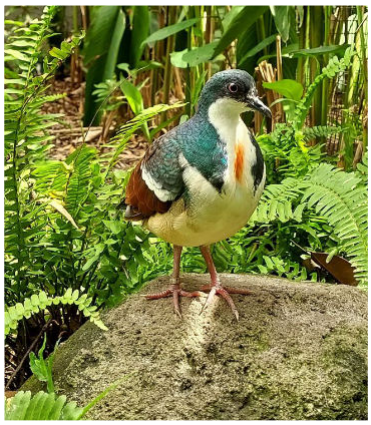
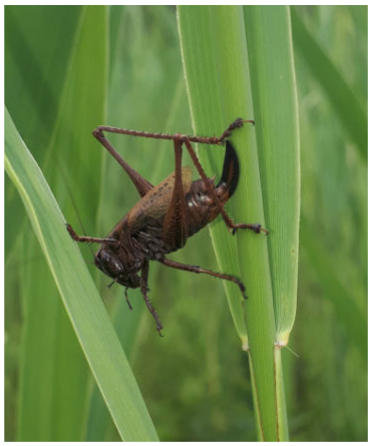
Global Conservation Translocation Perspectives: 2025

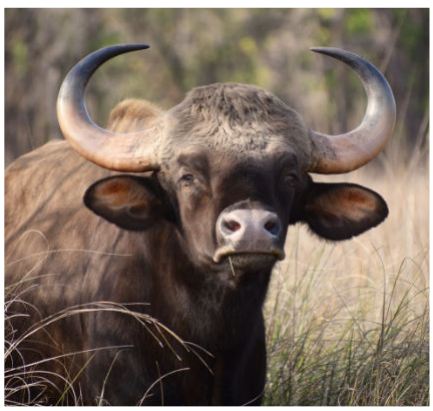
Case studies from around the globe - 8th Edition

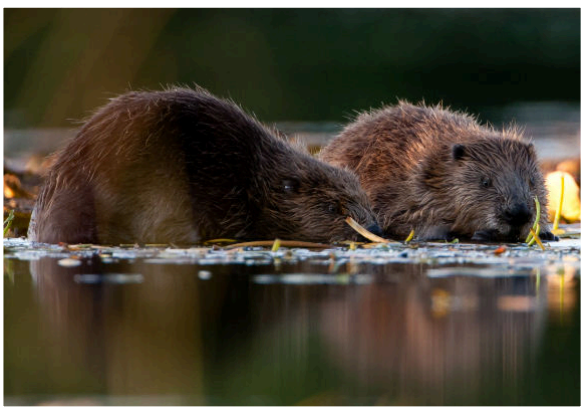
Edited by Pritpal S. Soorae







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Cover Photos:

(Clockwise from top-left)

- Muff river prawn (*Macrobrachium pilimanus*), Singapore

- Negros bleeding heart dove (*Gallicolumba keayi*), Philippines © Talarak

- Blanding's turtle (*Emydoidea blandingii*), Canada © Adderley Heron

- Black rhinoceros (*Diceros bicornis minor*), Zimbabwe © Gonarezhou Conservation Trust

- Eurasian beavers (*Castor fiber*), Scotland

- Grey mangrove (*Avicennia marina*), United Arab Emirates © Environment Agency-Abu Dhabi

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- Curved-back rice fish (*Oryzias curvinotus*) © Tommy Hui

- Project partners Orinoco crocodile (*Crocodylus intermedius*), Colombia © Juan Carlos Enciso - Fundación Natibo

(Center picture)

- Adriatic marbled bush-cricket (*Zeuneriana marmorata*), Italy © Filippo Maria Buzzetti

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Dr. Axel Moehrenschlager
Chair of IUCN SSC Conservation Translocation Specialist Group; Panthera

We all depend on nature…and nature depends on us. We can and must save it. Conservation translocations, having been used for over 5,000 species across all biomes, exemplify courageous actions to make a powerful difference.

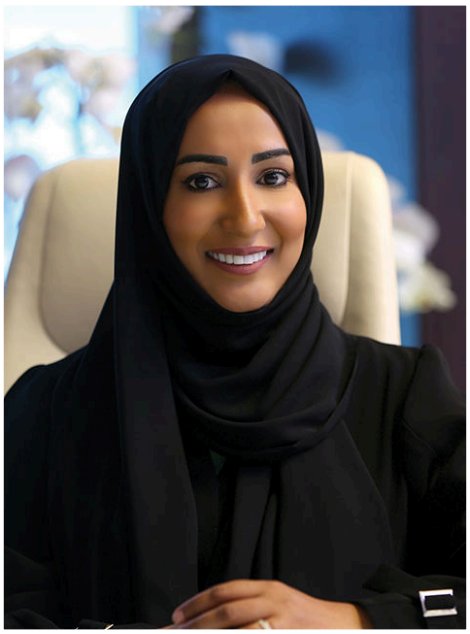
Once again, my friend Pritpal Soorae builds on an impressive legacy of inspiring case studies. We are deeply grateful to Mandai Nature-Singapore, Environment Agency-Abu Dhabi, and SSC for their profound support.

The diversity of species in this volume highlights crucial current priorities. New Zealand tuatara conservation illustrates the need for respectful co-planning and co-management with Indigenous Peoples. In CTSG, we are focusing on improved guidance and practice towards decolonizing conservation translocations.

Illegal pet trade of Brazil's golden conure parrot, begs the question what should be done with animals or plants that are successfully rescued from harm. In response, CTSG and partners have now launched the 'IUCN Guidelines for the Responsible Translocation of Displaced Organisms'. Having lost wild populations, the milu from China showcases the need to help species which have become entirely dependent on breeding or propagation under human care. Building on years of efforts, CTSG and partners now launched the 'Extinct in the Wild Action Partnership' to empower global efforts for such animals and plants as they teeter on the very edge of extinction.

Sometimes highly endangered species cannot return safely to their previous wild range because of current or future inescapable threats. CTSG is focusing on improved policy and actions for 'assisted colonization', referred to for Singapore's muff river prawn, to enable exceptional cases where translocations into new environments may be critical. At the same time, we focus on curbing ill-justified translocations of species beyond their indigenous range.

Recent CTSG training in Brazil, Australia, and Kenya continued to empower local leaders to escalate responsible conservation actions on the ground. After all, we believe that conservation is all about people….people like you! We need and welcome you to make a difference with us…for the species, for the Planet, and for ourselves.



H.E. Dr. Shaikha Salem Al Dhaheri
Secretary General, Environment Agency – Abu Dhabi

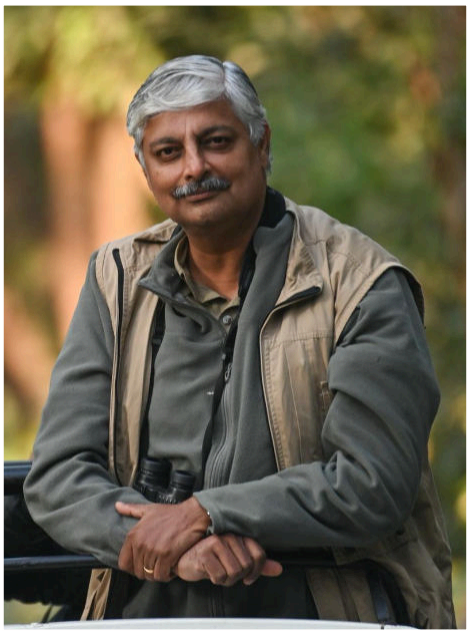
It has been four years since the last edition of Global Conservation Translocation Perspectives 2021, and I am delighted to see this 8th issue being released as we enter a new triennium after the 27th IUCN World Congress, which was held in Abu Dhabi in the United Arab Emirates and jointly hosted by the Ministry of Climate Change and Environment and the Environment Agency-Abu Dhabi (EAD).

This edition features case studies from 41 countries across the globe, showcasing the diversity and innovation in conservation translocation efforts. From swamp crayfish in Singapore and freshwater fish in Hong Kong, to deer in the Philippines and Orinoco crocodiles in Colombia. The range of species covered reflects the dynamic and evolving nature of global restoration initiatives.

I am particularly pleased to highlight two plant case studies from Abu Dhabi, UAE – the grey mangrove and white saxaul. The grey mangrove is a vital coastal species, playing a key role in blue carbon ecosystems and providing other ecosystem services, such as habitats for other species and protecting coastal areas from storms. The white saxaul, an inland desert species, is both ecologically and culturally significant, contributing to the resilience of desert ecosystems.

On the international front, EAD continues to play a leading role in the reintroduction of the scimitar-horned oryx and addax in Chad. Thanks to these sustained efforts, both species have made a comeback, with over 600 scimitar-horned oryx and more than 100 addax now thriving in the wild. Notably, the scimitar-horned oryx has been reclassified from “Extinct in the Wild” to “Endangered”, marking a major milestone in species recovery and a testament to what long-term partnerships and leadership commitment can achieve.

I would like to thank Pritpal Soorae for editing these case studies, ensuring that best practices in species and ecosystem restoration are shared with the wider conservation community, fostering collaboration and learning across borders.



Vivek Menon
Chair, IUCN SSC and Councillor IUCN

I warmly applaud this 8th volume of the CTSG series that documents fantastic conservation translocation stories from across the globe. Having been a long time member of this group and of the IUCN SSC Steering Committee for the past two quadrenniums, I have seen several of these volumes that bring together 459 case studies. Each one allows me to wander from the bulrushes of a European swamp to the arid eco regions of Arabia, from the coils of a cold blooded snake to the warmth of a young fledged warbler. And each volume documents hope, as conservation heroes from around the world move animals and plants (and hopefully fungi too) in order to recover species, bring back ecosystems and react proactively to a climate that is changing by day.

In some volumes, such as this one, a long term project is reviewed over the years such as the fascinating story of the Arabian oryx in Israel that in 46 years turned the original 8 animals through supplementations and breeding into 147! Some others are pilots or test studies to see how different techniques help, for example, for mangroves to thrive in the UAE. It is critical that two projects that were listed as Failures make this volume alongwith 39 others of differing success.

To document and learn from failures is a critical aspect of conservation and indeed of life itself. The way in which each volume is designed allows us to do this as simple headings like major difficulties faced, broad underlying problems and lessons learnt from success or failure captures the key essence of the case study in question.

In the Species Survival Commission there are over 200 specialist groups but the CTSG is indeed special in the breadth of its taxonomic and spatial coverage as well as the immediate implication of the guidelines that it regularly brings out and updates to the movement of any living organism across the world. These volumes are an outstanding contribution for researchers, managers, governments and civil society who work to conserve our fragile nature.



Dr Sonja Luz
CEO Mandai Nature, Singapore

We all know that long-term conservation success depends not only on the release of individuals, but primarily on protecting natural habitats and engaging with local communities who live alongside wildlife. Only when local communities act as stewards of these ecosystems, threats and pressures can be effectively mitigated, and coexistence becomes possible.

Unfortunately, deforestation, human-wildlife conflict and illegal wildlife trade remain key drivers of species extinction, and translocations have become an increasingly important tool to tackle these threats.

Many displaced organisms, and especially those of high conservation value, require careful assessments and intensive preparation prior to their release back into appropriate and safe wild habitats. Their survival depends on the dedication and perseverance of conservation practitioners working to secure their future.

Collaboration between ex situ and in situ experts is critical to this success, and organisations that rescue and breed insurance colonies usually provide a precious lifeline, which however can only be realised by working closely with experts in the field and those who best understand the ecological, cultural and social landscapes into which these animals are returned.

As demonstrated through many case studies in this book, species conservation is a long and complex process which requires courage to test new approaches, persistence in the face of setbacks, and the ability to share failures alongside successes. Built from trials, setbacks and hard-earned successes, the stories shared here offer great lessons we can draw from.

Mandai Nature is proud to be a member and supporter of the IUCN SSC Conservation Translocation Specialist Group and its communities, and we commend the efforts documented here as a crucial step towards securing a wilder, more resilient future for our region and beyond.

An overview and analysis of the case studies

Pritpal S. Soorae, Editor

Introduction

This is the 8th issue in the Global Conservation Translocation Perspectives series and has been produced in the same standardised format as the previous editions. There has been a slight change by the addition of a new criteria such as Broad Underlying Problems and under Major Difficulties Faced the following sub-headings have been added a) biological, b) operational, c) social, d) legislative, and e) other.

Case studies per issue

Table 1. The number of case-studies (some with multiple releases in different sites) in 8 issues of the reintroduction/conservation translocation perspective series

Year	2008	2010	2011	2013	2016	2018	2021	2025	Total
Number of case-studies	62	72	50	52	54	59	69	41	459

This is a total of 459 case studies in all seven issues as shown in Table 1 above.

IUCN Statutory Regions and number of individual projects as some case-studies have multiple releases/plantings

The IUCN Statutes have established a total of eight global regions for the purposes of its representation in council. The IUCN's "statutory regions" are a list of States by Region, as per article 16 and 17 of the Statutes and Regulation 36 of the Regulations.

All eight global regions are represented within these case studies and the numbers of case-studies in the regions are as follows:

1. North America & Caribbean - 3 case studies
2. West Europe - 10 case studies
3. South & East Asia - 9 case studies
4. Oceania - 5 case studies
5. West Asia - 5 case studies
6. Africa - 3 case studies
7. Meso & South America - 15 case studies
8. East Europe, North & Central Asia - 3 case studies

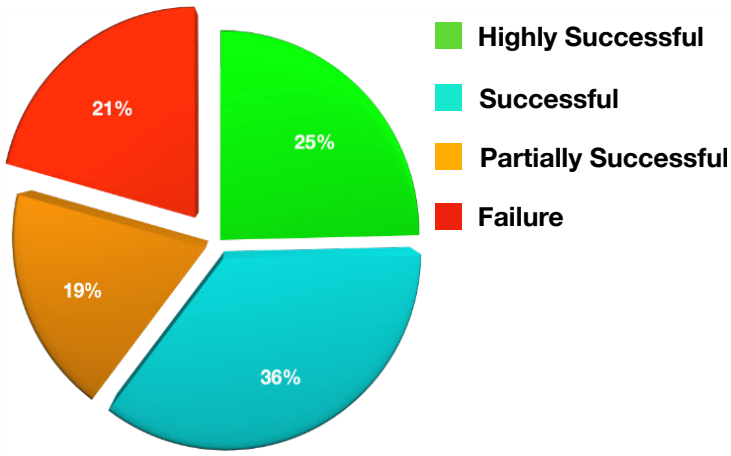
There are 53 individual projects (in 41 case-studies) ranked for the success/failure criteria.

Success/Failure of projects

The projects presented here were ranked as highly successful, successful, partially successful and failure. Out of the 41 case studies, there were some cases of multiple rankings, as some projects had multiple releases with a total of 53 different releases/plantings.

A total of 13 projects were highly successful (25%), 19 were successful (36%), 10 were partially successful (19%) and 11 were listed as failures (21%) as shown in Figure 1.

Figure 1. The success and failure rankings of projects

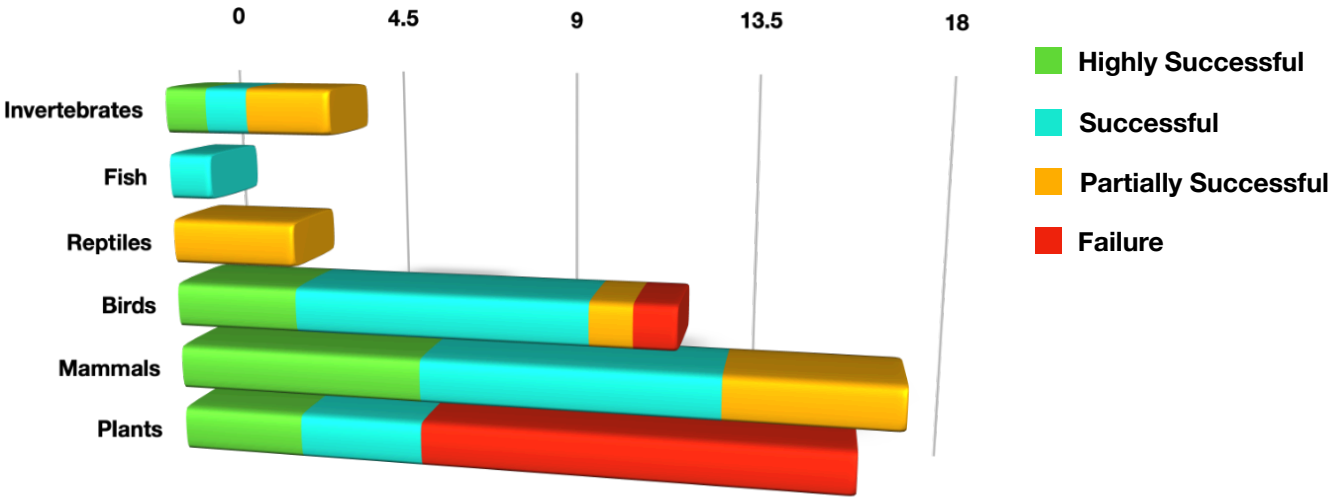


Success according to the taxa

An analysis was done to gauge the three different levels of success (highly successful, successful and partially successful) and failure against the six major taxa i.e. invertebrates, fish, reptiles, birds, mammals and plants as can be seen in figure 2.

- Invertebrates had highly successful, successful and partially successful comprising the majority of case-studies.
- Fish had one case study which was ranked as successful.
- Reptile case-studies were all listed as partially successful.
- Birds had all four categories namely highly successful, successful (comprising majority of the case-studies), partially successful and failure.
- Mammals were ranked as highly successful, successful (majority of the case-studies) and partially successful.
- Plants had highly successful, successful and failure comprising majority of the case-studies.

Figure 2. Success and failures of projects compared with the six different taxa.





Assisted colonisation of the muff river prawn in Singapore

Daniel J. J. Ng[1]*, Chin Yu Xun[2] & Cai Yixiong[3]

Introduction

The muff river prawn (*Macrobrachium pilimanus*) is a freshwater prawn species, ~5 cm long and found in Indonesia, Brunei, Singapore and Malaysia (Cai et al., 2004). Classified as Least Concern according to the IUCN Red List, it is listed as an Endangered species in Singapore (NParks, 2023) as the species is only known from one locality locally. To ensure the survival of the species in Singapore, the species was included under the Species Recovery Programme by the Singapore National Parks Board (NParks).

A multi-pronged approach was adopted, which included long-term monitoring, research, translocation, and captive breeding. Wild individuals were translocated to suitable streams in Singapore, resulting in the expansion of their wild range. Here, we report on the assisted colonisation of a stream where the species was previously absent. This was done through translocation of wild individuals from their native range to the new site.

Main Goals

1. Expand its distribution of the species through assisted colonization of wild individuals to a suitable stream.
2. Develop a long-term monitoring plan for established populations.

Success Indicators

1. The released prawns survived at the new site to reproduce.
2. Progeny recruitment at the new site.
3. An increase in the relative abundance of the new population.

Project Summary

Feasibility

The muff river prawn, a member of the *M. pilimanus* species group (Cai et al, 2004; Siriwut et al., 2020), is widely distributed in Indonesia, Brunei, Singapore and Malaysia. However, in Singapore, it is classified as Endangered due to its dependence on hill stream habitats, which are scarce in the country. Singapore's predominantly flat terrain, with limited elevated landscapes, restricts the availability of suitable habitats. This in turn poses a significant challenge to the species' long-term survival.



Researcher at prawn release site

This project seeks to expand the distribution of the muff river prawn within Singapore by establishing new populations in suitable habitats. This requires translocating enough individuals, either from wild populations or through captive breeding, to targeted sites that meet the species' ecological needs.

Implementation

Conservation efforts for the muff river prawn commenced in December 2021. Such efforts included the translocation of wild individuals to a stream where the species was previously undetected. Stream habitat suitability was conducted beforehand to identify suitable sites, ensuring that release sites closely mirrored donor sites in terms of water parameters and stream characteristics. The site was also selected based on the absence of other prawn species to maximise the chances of successful population establishment.

Between October 2022 and January 2023, a total of 58 sub-adult and adult individuals were translocated from the wild and released into a suitable stream over three separate events.

Post-release Monitoring

Post-release monitoring of the stream where muff river prawns were introduced was conducted regularly. Surveys were carried out to assess the population.

Monitoring began in November 2022 and during the first few months of monitoring, very few individuals (<10) were detected. By February 2023, breeding was confirmed by the presence of progeny. By December 2023, over 80 individuals were recorded throughout the stream, spanning both upstream and downstream sections of the release site. The presence of progeny and increase in prawn numbers detected confirmed that the population was reproducing successfully, indicating that the translocated prawns had established a self-sustaining population.

Major Difficulties Faced

Biological

- Limited information about species life-history.

Broad Underlying Problems

- Limited suitable streams for translocation.
- Potential limited genetic pool in Singapore's population.

Major Lessons Learned

- New populations of prawns can be established provided enough individuals are translocated.
- The absence of other prawn species facilitates establishment.
- Long-term monitoring (at least a year) is required to determine if new populations are established.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- A better understanding of habitats requirement of the targeted species based on habitat characterization study on the donor site.
- Strong commitment and support by various stakeholders to persist with conservation efforts.
- Continuous communication between the stakeholders involved during the project.
- Population persisted at the translocation site for over one year and new generation of prawns established at the translocation site.
- Prawn abundance at the translocation site increased over time and individuals from this successful translocated population were subsequently used to populate other suitable streams.

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Author Details

[1] Daniel J. J. Ng, National Parks Board, Singapore Botanic Gardens, 1 Cluny Road, Singapore 259569,*
Daniel_NG@nparks.gov.sg

[2] Chin Yu Xun, yuxun.sg@gmail.com

[3] Cai Yixiong, CAI_YIXIONG@nparks.gov.sg



Successful conservation translocation of the Adriatic marbled bush-cricket in North East Italy

Filippo Maria Buzzetti[1]*, Yannick Fanin[2] & Axel Hochkirch[3]

Introduction

The Adriatic marbled bush-cricket (*Zeuneriana marmorata*) is a medium sized bush-cricket endemic of North East Italy and Slovenia, living in wet habitats where it is distributed in isolated populations of different extension ranges. It is listed as Endangered (EN) by IUCN (Hochkirch et al., 2016a), and included in the European Red List of Grasshoppers, Crickets and Bush-crickets (Hochkirch et al., 2016b) and focus of two IUCN national action plans, one for Italy (Hochkirch et al., 2017a) and one for Slovenija (Hochkrich et al., 2017b).

The scattered and isolated sub-populations are likely remnants of a wider meta-population jeopardised by human activity (farming, land reclaiming), but new sub-populations have been found in the North Italy inland (Buzzetti et al., 2021). Conservation projects, including translocation and ex situ rearing, resulted in a newly founded subpopulation, the first successful attempt of Orthoptera reintroduction in Italy.

Main Goals

The translocation was part of a wider project aimed at species study and conservation.

1. Establish a new subpopulation in suitable habitat.
2. Monitoring the status and expansion of the new subpopulation.
3. Understanding the best practices for translocation effectiveness.
4. Assess the most effective ex situ rearing method.

Success Indicators

1. Agreement with local authorities on habitat management.

2. Training local conservationists for detecting target species.

3. Presence of young and adult individuals after first release.

4. Persistence of the new subpopulation for at least 3 years.



Releasing crickets at the release site

Project Summary

Feasibility

Field surveys in Italy over the last decades confirmed the presence of the species in isolated subpopulations along some wet habitats of the NE Italian coast. Cooperation with the University of Trier (Germany) ensured the presence of students for field activity since 2018. Financial support has been obtained from The Mohamed Bin Zayed Species Conservation Fund and from IUCN SSC Internal Grant. Permission of catch and release translocation, plus ex situ breeding was enacted by the autonomous region Friuli-Venezia Giulia. Some suitable sites for release have been identified, in agreement with local authorities and conservationists also for management. The Fondazione Museo Civico di Rovereto led the conservation project.

Implementation

In 2021, 50 young and adult individuals of both sexes were collected from Isola della Cona (wild living) and translocated to Schiavetti, until then without the species. In 2022, young and adult individuals F1 (generated by individuals released in 2021) were observed in Schiavetti, then a second translocation of 50 individuals took place from Isola della Cona (wild living). In 2023, adult and young individuals of both sexes were observed in an area larger than that occupied in 2022. These individuals were F1a (generated by individuals released in 2022) and F2 (generated by individuals released in 2021) since the eggs of Orthoptera can hatch in subsequent years.

Post-release Monitoring

The species is monitored actively during day time by visual inspection of the suitable habitat and acoustic detection of singing individuals (adult males) from the early season (mid May) to the end of phenology (late July).

Major Difficulties Faced

Biological

- *Adverse climate/weather:* The years 2021 and 2022 have been extremely dry years. The first semester of 2022 had very less rain than usual, preventing the submergence of the vegetation where *Z. marmorata* lay eggs. The submergence of eggs seems to be necessary for hatching.

Operational

- The ex situ rearing was unsuccessful during the first attempt. The individuals collected during 2021, were reared in cages and laid eggs, but during 2022 no F1 hatched.

- They were successful at the second attempt with the same conditions of the first (F1 hatched in 2023 from eggs laid in



A female cricket from Schiavetti - 2022
© Filippo Maria Buzzetti

2022 and kept submerged for months).

- Best breeding practices are not clear yet.

Social

- The media response has been little, with few newspaper articles. The public showed no interest in following the project updates.

Other

- The project took place exactly during the COVID emergency, making difficult, if not impossible, the continuous monitoring and the ex situ activities.

Broad Underlying Problems

- Climate change is a possible challenge.

Major Lessons Learned

- The importance of networking with local authorities, institutions and conservationists is a key factor in: obtaining necessary permits, finding access to existing populations, surveying the territory to find new localities with suitable habitat, managing the protected area and locality of re-introduction, immediate and continuous monitoring.

- Monitoring the re-introduction locality is probably the most important issue of post-release activity: it allows to detect individuals of *Z. marmorata*, assess the extension and density of the population. Continue monitoring is necessary to understand the status of the newly founded sub-population.

- It has to be spent more effort in involving the public on project awareness, scheduling conferences and workshops to an audience wider than only specialists.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- Most success came from the involvement of local institutions and conservationists and their interconnection with project supervisor.

- A good planned activity, referring to the National Action Plan, was essential to perform the project correctly.

- The translocation of *Z. marmorata* is an in-progress conservation project and took place during COVID emergency, these factors limited the success (not Highly Successful) of the activity because:

  - more time (at least 1 year more) is needed to monitor the presence of the translocated population.

  - COVID emergency limited the time spent in lab, impeding the correct control of the ex situ rearing facilities, therefore hindering the understanding of the most correct breeding conditions.

  - More localities with suitable habitat and more suitable donor

subpopulations have to be chosen for future translocations.

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Author Details

[1] Fondazione Museo Civico di Rovereto, Borgo S. Caterina 41, I-38068 Rovereto (TN), Italy, buzzettifilippo@fondazionemcr.it*

[2] Corpo Forestale Regionale Friuli Venezia Giulia, Italy, yannickfanin@gmail.com

[3] Musée National d'Histoire Naturelle, Luxembourg, hochkirch@uni-trier.de



Cricket habitat along the Stella River



Reintroductions of the endangered dark bordered beauty moth in the Cairngorms National Park, Scotland

Helen R Taylor[1]*, Adam Button[1], Eleanor Barrie[2], Anne Elliott[3], Georgina Lindsay[1], Pete Moore, Tom Prescott[4], Brigid Primrose[3], James Silvey[5], Genevieve Tompkins[2], Stewart Taylor & Hayley Wiswell[6]

Introduction

The dark bordered beauty moth (*Epione vespertaria*) (DBB) is a pan-European and Asian species that does not currently have a global IUCN Red List status, but is listed as Endangered in the UK (Fox et al., 2019), where it is restricted to three sites; two in Scotland (Strathspey and Deeside) and one in England (North Yorkshire) suggesting a wider distribution historically. Reintroduction efforts for this species are currently focused on establishing additional populations in Strathspey (Cairngorms National Park). The project comprises a conservation breeding programme at RZSS' Highland Wildlife Park, reintroduction releases into suitable habitat, and surveys of existing and newly introduced populations.

This is the first time a full-scale conservation breeding and reintroduction effort has been run for this species and all work follows the IUCN Guidelines for Reintroductions and other Conservation Translocations and the Scottish Code for Conservation Translocations.

Main Goals

1. Establish an ex situ conservation breeding programme using founders from the Strathspey population in Scotland to breed individuals for reintroductions to additional sites.
2. Establish at least one additional population via reintroductions using individuals from the conservation breeding programme.
3. Conduct annual post-release monitoring to establish whether populations are becoming established.

Success Indicators

1. At least 400 eggs per year produced by the conservation breeding programme.
2. Confirmed breeding of released individuals at reintroduction site(s).
3. In the longer term (i.e., the next 5 years), self-sustaining populations in at least two release sites.



Release project steering group at release site

Project Summary

Feasibility

In Scotland, DBB caterpillars feed on the leaves of fresh aspen suckers (the clonal runner shoots of aspen trees), while adults feed on the nectar of wildflowers such as devil's bit scabious. Maintaining this mix of food plants requires careful grazing management, but there are several sites in Strathspey known to have this mix plus the correct management regime to maintain it. While a large-scale breeding programme had never been attempted, the species had been reared through one breeding cycle privately by members of the species' steering group so some data on husbandry methods were available.

Implementation

A new conservation breeding programme for DBB moths was started at RZSS Highland Wildlife Park in 2021 using 40 eggs collected from 5 females at the Strathspey site. The programme produced 497 eggs in 2022 and 3,461 eggs in 2023. This breeding success has enabled reintroduction releases into an additional site in Strathspey assessed as having suitable habitat and management. In 2023, 176 caterpillars and 27 adults were released, and 1,500 eggs plus 979 caterpillars by July 2024. It is currently unclear which life-stage is best suited to releases in this species, hence adoption of a mixed strategy.

Post-release Monitoring

Eggs and caterpillars of this species are extremely challenging to detect in the wild; post release monitoring is via moth-trapping for adults. One year of post-release moth trapping has been conducted to date (July 2023). Occurring after the first round of caterpillar releases to the reintroduction site, this trapping effort was designed to detect successful pupation of caterpillars released earlier in the year rather than reproduction in the reintroduced population. All adult moths released from the breeding programme are marked to distinguish released and wild moths. Four unmarked DBB moth adults were caught over two nights of trapping in July 2023.

Major Difficulties Faced

Biological

- *Other disease:* Within the breeding programme, provision of sufficient, fresh aspen for caterpillars was extremely costly in terms of staff time in the 2023 breeding season. In the 2024 season, a switch to using live aspen whips in caterpillar enclosures was made to

reduce the amount of time spent changing out food for increasingly large numbers of caterpillars.

Genetic

- Although not currently causing any detectable issues, we are conscious that the gene pool for the conservation breeding programme is potentially relatively shallow, with just 5 female founders from a wild population that is, itself, relatively small and isolated. To mitigate the risks associated with low genetic diversity and inbreeding, the conservation breeding population is carefully managed.

- Sampling efforts are underway this season (2024) to collect DNA from all three remnant populations of DBB moths in Britain to allow assessment of genetic diversity and evaluate whether mixing individuals from the different populations may be advisable in future to improve genetic diversity.

Operational

- Finding release sites for this species with the appropriate habitat and under suitable management is challenging due to the grazing regime required to keep DBB habitat in good condition.

- Thus far, releases have only taken place at one site. However, an additional site has been identified for releases in 2025 and other sites are being evaluated.

Other

- One of the overarching challenges for this project is a lack of data on DBB biology, ecology, and behavior. The scarcity of the species means it is rarely observed in any of its life stages in the wild, thus information on food plants, egg laying sites, and activity patterns, for example, is limited.

- Disease screening is also challenging; as with many invertebrates, there is a paucity of data regarding pathogens that affect this species. The conservation breeding programme is helpful in addressing some of these knowledge gaps as it allows trialing the provisioning of different food plants and egg laying substrate, and the RZSS vets are able to send deceased individuals for histopathology testing.

- The caveat to this is that an ex situ setting is not equal to being in the wild, thus preferences observed in the breeding programme must be interpreted with caution as they may not reflect wild behavior or ecology.

Broad Underlying Problems

Suboptimal habitat

- As mentioned above, finding appropriate release sites for this species is challenging. Habitat loss and degradation is thought to be a major driver of the decline of this species and is difficult to fully address. We are hopeful that promotion of success in existing release sites may help uncover other sites in future and prompt landowners to engage in appropriate management practices that will help this species persist.

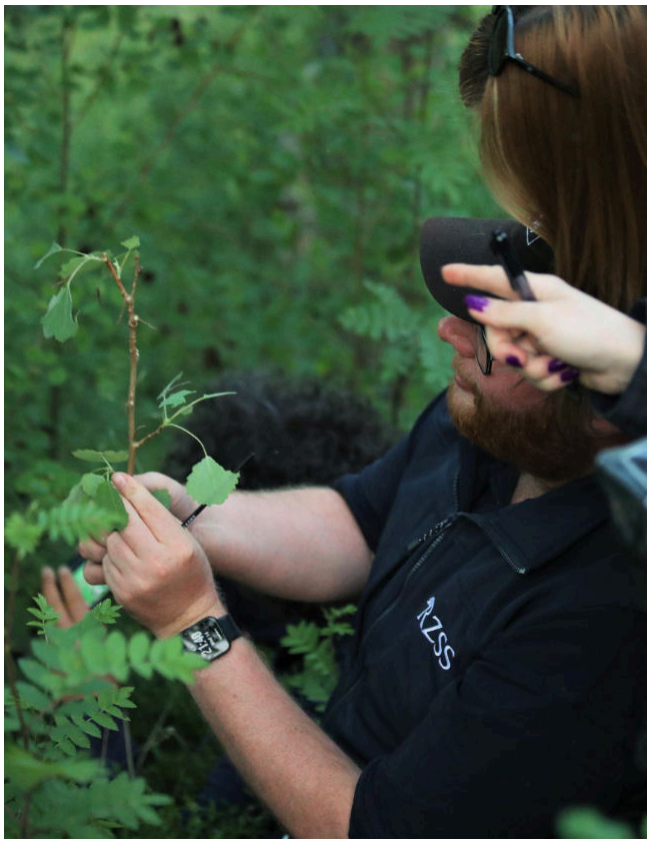
- However, sites are likely to remain fragmented in at least the short to mid-term as connecting them up across the current landscape would be very difficult. Thus, even with more habitat, the ability of DBB to move between suitable habitat patches will be limited.

Climate change

- As for many invertebrates, climate change could bring challenges for DBB, both in terms of triggers for life stage changes (i.e., hatching and pupation) and mismatches between the timing of life stages and the budding/flowering of food plants. This can be addressed to an extent in the conservation breeding programme by using climate control in the breeding facilities to provide optimal conditions, but this will not solve the issues potentially facing this species from climate change in the wild.

Major Lessons Learned

- To date, much has been learned about raising and breeding DBB ex situ at scale. This has enabled optimization of



Steering group working at release site

caterpillar feeding, including using live aspen whips to minimize the time spent on food changes when large numbers of caterpillars are being held, observing courtship and mating behavior in the species for the first time, and observing adults feeding on three species of flowering plant, which optimizes food provision and could assist identification of release sites in future.

- Developmental abnormalities have also been observed in the conservation breeding population, including crop rupture in a caterpillar, deformed wings at emergence in a handful of adult moths and failure to initiate pupation leading to late-stage death in caterpillars. Understanding the drivers of these conditions in partnership with RZSS' vets will enable further optimization of the breeding programme.
- Techniques for transport and release of both eggs and caterpillars have been trialed and refined as part of the reintroduction release work.
- Include any approaches that were particularly successful in mitigating any difficulties.
- The partnership approach employed in the DBB conservation programme allows effective working between experts with a variety of skills and knowledge. The Dark Bordered Beauty Steering Group and the Rare Invertebrates in the Cairngorms partnership are both instrumental to the success of this project to date.
- Including egg releases and early instar caterpillar releases in the 2024 programme has been extremely helpful in managing the resource demands within the conservation breeding programme, but the efficacy of these release methods is still being tested.
- The long-term working relationship that one steering group member (S. Taylor) has established with the landowner at our initial release site has been instrumental in providing a suitable location to trial reintroduction releases of this species, highlighting the importance of good landowner relations for effective conservation translocation efforts.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reintroduction releases=Partially successful

Conservation breeding programme=Highly successful

Annual post-release monitoring=Partially successful

Reasons for Success/Failure

Conservation breeding programme

- The original success indicator was to produce at least 400 eggs per year and the maximum produced so far is 3,461 in the 2023 breeding season.
- We were able to commence reintroduction releases within the second year of the breeding programme, while maintaining the programme as an insurance population and to provide individuals for future releases.
- Monitoring individual behavior using bird



Moth caterpillar (left) and pupae (right)

nest box cameras and trialing different food plants for adult moths has produced some useful insights regarding ecology and behavior that add to our knowledge of this species' requirements and will hopefully enhance the success of reintroduction efforts.

Reintroduction releases

- The original success indicator was to confirm breeding of released individuals at reintroduction site(s). While we have confirmed pupation, we are too early in the project to confirm breeding, but hope to do so in the next 12 months.
- The reintroductions will only be considered successful/highly successful if populations can be proved to be self-sustaining (i.e., do not require regular reinforcement releases to continue in the long-term).

Annual post-release monitoring

- The original goal was to conduct annual post-release monitoring to establish whether populations are becoming established. We have so far conducted one round of post-release moth trapping. As mentioned above, this has demonstrated successful pupation of released caterpillars, but not reproduction by released individuals.
- For future releases to additional sites, we intend to conduct at least one egg-only release, followed by moth trapping during the flight season to test the efficacy of releasing eggs vs caterpillars vs a combination to establish best practice for reintroduction releases for this species.

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Author Details

[1] Royal Zoological Society of Scotland, Edinburgh Zoo, 134 Corstorphine Road, Edinburgh, Scotland,*
htaylor@rzss.org.uk
abutton@rzss.org.uk
glindsay@rzss.org.uk

[2] Rare Invertebrates in the Cairngorms Project, eleanor.barrie@RSPB.org.uk

[3] NatureScot, anne.elliott@nature.scot; brigid.primrose@nature.scot

[4] Butterfly Conservation, tprescott@butterfly-conservation.org

[5] RSPB, james.silvey@rspb.org.uk

[6] Cairngorms National Park Authority, hayleywiswell@cairngorms.co.uk



Reintroductions of the critically endangered pine hoverfly in the Cairngorms National Park, Scotland

Helen R Taylor[1]*, Carl Allott[1], Eleanor Barrie[2], Anne Elliott[3], Kenny Kortland[4], Georgina Lindsay[1], Iain MacGowan[5], Eileen Mathers[2], Jane Sears[6], Amelie Sumpter[6], Genevieve Tompkins[2] & Hayley Wiswell[7]

Introduction

The pine hoverfly (*Blera fallax*) is a Palearctic species listed as Least Concern on the IUCN global Red List, but Critically Endangered in the UK (Ball & Morris, 2014), being restricted to just one site: a forest patch in the Cairngorms National Park (CNP). Historical records suggest the species has always been range-restricted in the UK, with all records coming from within or near CNP. Reintroduction efforts for the species are currently focused on establishing additional populations in the Strathspey area of CNP.

This work follows reintroduction attempts previously reported in this series (Rotheray, 2010), which unfortunately proved unsuccessful. Building on lessons from this initial attempt and following the IUCN Guidelines for Reintroductions and other Conservation Translocations and the Scottish Code for Translocations, we have established a new breeding and reintroduction programme for this species in Scotland.

Main Goals

1. Establish an ex situ conservation breeding programme using founders from the remnant population in Scotland to breed individuals for reintroductions to additional sites.
2. Identify suitable sites for reintroductions and conduct habitat enhancements at these sites to facilitate releases.
3. Establish at least three additional populations via reintroductions using individuals from the conservation breeding programme.
4. Conduct annual post-release monitoring

to establish whether populations are becoming established.

Success Indicators

1. At least 500 individuals per year produced by the conservation breeding programme.
2. Confirmed successful breeding of released individuals at reintroduction sites.
3. Three additional self-sustaining populations of pine hoverflies established in Scotland.



Field staff at project release site

Project Summary

Feasibility

Pine hoverflies require rot holes in Scot's pine trees for larvae to feed and grow in and flowering plants such as rowan for adults to feed on. Scot's pine forest with a mix of deciduous trees and flowering plants is now rare habitat in Scotland but does exist in patches. Within these patches, artificial rot holes can be created in stumps and logs of felled Scot's pine trees to act as both pine hoverfly larvae release habitat and egg-laying sites for future generations. The species was previously bred in captivity as part of a PhD project (Rotheray, 2012), so husbandry protocols were available.

Implementation

A new conservation breeding programme for pine hoverflies was started at RZSS' Highland Wildlife Park in 2018 using 25 founders collected from the one remnant UK population (Taylor et al., 2021). By 2021, the programme was producing 7 - 8,000 larvae per year. In 2021, reintroduction releases commenced into three sites assessed as suitable habitat for the species and with ongoing artificial rot hole creation. Between 5,500 - 7,080 larvae per year were released between 2021 - 2024. A fourth release site was added in 2023. Breeding, rot hole creation, and releases are ongoing and additional release sites are being sought out.

Post-release Monitoring

Larvae are surveyed in artificial rot holes every September. While pine hoverflies typically have an annual life cycle, it is possible for them to spend 2 years as larvae (semivoltine development). Thus, if larvae are found in a hole that had larvae released into it within the past 18 months, it is not possible to tell if these were released or from wild-laid eggs. Larvae found in holes that have not had larvae released into them within the past 18 months are confirmed as wild-laid. We have recorded wild-laid larvae at all three of our initial release sites.

Major Difficulties Faced

Biological

- *Other disease:* In November 2021, we had a fungal outbreak in the pine hoverfly conservation breeding programme. A total of 59 larvae (out of around 3,000 being housed at that time) died. The outbreak led to changes in climate control protocols and the materials used in the programme.

- *Genetic:* We know that the conservation breeding population of pine hoverflies is descended from, at most, 2 females who were the only two to lay eggs in the 2019 breeding season. To mitigate issues of low genetic diversity and possible inbreeding, we carefully manage our breeding lines within the breeding programme and we bring two individuals from the wild remnant site into the breeding programme each year, but are aware that due to its small size, genetic diversity in the wild population is also likely low. The species' genome has been sequenced by the Darwin Tree of Life initiative (Taylor et al., 2023) and the RZSS WildGenes team is currently undertaking whole genome skim resequencing to assess genetic diversity both in and outside the breeding programme and help us manage this more effectively.

Operational

- A constant challenge with this project is having sufficient artificial rot holes to release larvae into. Cutting new artificial rot holes is not an insignificant logistical undertaking and it has been challenging to keep up with the demands of releasing ~6,000 larvae/year.

- To help address this, additional planning effort is being put into artificial rot hole creation and additional release sites are being surveyed for suitability to found new populations of pine hoverfly and reduce the pressure on existing sites.

- An overarching challenge for the pine hoverfly conservation programme is a lack of information regarding the biology, ecology, and behavior of the species in the wild. Adults are rarely encountered in the wild and thus observations of feeding, mate seeking, egg-laying, or micro-climate preferences are scant to non-existent. Similarly, disease screening in this species is hampered by the paucity of literature available. Much has been learned via having pine hoverflies in the conservation breeding programme and some of this information has informed selection of release sites (e.g., a preference for rowan flowers as an adult food source), but we are conscious that ex situ preferences are not always a full reflection of wild behavior and so all information is treated with caution.

Broad Underlying Problems

- *Suboptimal habitat:* The main driver of decline for this species is habitat loss and fragmentation and this remains an issue. Identifying additional release sites with optimal pine hoverfly habitat remains challenging and regenerating forest will play an important part in improving connectivity between the current release sites. If sites are not connected in future, then population fragmentation (and associated genetic issues) is a risk.

- *Climate change:* As for many invertebrates, climate change poses issues for pine hoverflies both in terms of triggers for life-stage changes (i.e., pupation initiation, duration, and becoming semivoltine), and pulling individuals out of sync with food sources (e.g., the timing of rowan flowering). While temperature and other environmental conditions can be controlled in the breeding programme facilities, this is a much bigger challenge for the reintroduced wild populations.

- *Other:* Underscoring the habitat issues for pine hoverfly is a paucity of data on what the species' requirements genuinely are. For example, as the adult form is so rarely recorded in the wild, there have been very few observations of adults feeding. The conservation breeding programme has been invaluable in terms of trialing different food plants for adult flies and rowan does seem to be a preferred food source. If reintroduced populations are found to be unsuccessful, a lack of available data on the species' requirements could make it challenging to understand why and to adapt accordingly.

Major Lessons Learned

- Improvements in animal husbandry allowing the conservation breeding programme to be scaled up while mitigating disease risk (includes provisions of ovipositing material to allow

females to lay eggs whenever they wish to optimize egg production and more sophisticated climate control abilities to minimize disease risk).

- Identification of key food plants (especially rowan) allowing more complete evaluation of suitability of release sites.
- Data showing that both artificial rot holes cut vertically into stumps and horizontally into logs would hold water and provide good habitat for larvae to grow and pupate in increased options for artificial habitat creation at release sites.
- The pine hoverfly conservation programme is run as a partnership between members of the steering group and as part of the Rare Invertebrates in the Cairngorms project. Being able to draw on the skills, expertise, and resources of a variety of partners has been instrumental in the success of this project to date. The steering group has also recently come together to produce a new conservation action plan for the pine hoverfly, which will be finalized in late 2024 and will guide ongoing conservation work on this species.
- Intensive post-release monitoring is providing data that allow an evidence-based approach to release management and decision-making. This allows us to evolve our methods where needed and facilitates consideration of appropriate exit strategies for both success and failure.
- Having vets on staff at the zoo allowed us to respond quickly to disease challenges in the conservation breeding programme and take immediate action to minimize the risk of this challenge re-occurring.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reintroduction releases=Partially successful

Conservation breeding programme=Highly successful

Reasons for Success/Failure

Conservation breeding programme

- The original goal was to breed at least 500 larvae for release per year and we currently produce around 8,000 each year.
- We have more than enough individuals to



Overview of habitat at release site

enable annual releases of ~6,000 larvae into our reintroduction sites while maintaining a conservation breeding programme as insurance against extinction and to facilitate future releases.

- Husbandry methods are well-refined and breeding can be maintained/scaled up or down as required.
- Reaching this point has required a large investment of time from RZSS conservation project staff and vets and a considerable financial investment in purpose-built facilities that allowed the breeding programme to be upscaled in a way that maximised success and the well-being of individual pine hoverflies.

Reintroduction releases

- The original goal was to confirm breeding of released individuals at reintroduction sites and to establish three self-sustaining populations of pine hoverflies in Scotland (in addition to the one remnant population).
- We have currently confirmed breeding at three of our four reintroduction sites, but we consider these populations to be in the establishment phase rather than being self-sustaining.
- The reintroductions will only be considered successful/highly successful if populations can be proved to be self-sustaining (i.e., do not require regular reinforcement releases to continue in the short and long-term).
- The first round of testing for sustainable populations is took place at one of our four release sites in 2024. No releases were conducted at this site in October 2023 or March 2024. Thus, the larval survey at this site in September 2024 will give an indication of how well the reintroduced populations perform in the absence of additional releases.

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Author Details

[1] Royal Zoological Society of Scotland, Edinburgh Zoo, 134 Corstorphine Road, Edinburgh, Scotland,*
htaylor@rzss.org.uk
callott@rzss.org.uk
glindsay@rzss.org.uk

[2] Rare Invertebrates in the Cairngorms Project, eleanor.barrie@RSPB.org.uk

[3] NatureScot, anne.elliott@nature.scot

[4] Forestry and Land Scotland, kenny.kortland@forestryandland.gov.scot

[5] Malloch Society/National Museums of Scotland, imacgowan9@gmail.com

[6] RSPB,
jane.sears@rspb.org.uk
amelie.sumpter@rspb.org.uk

[7] Cairngorms National Park Authority, hayleywiswell@cairngorms.co.uk



Reintroduction of a locally threatened fish, the curved-back ricefish, to a Hong Kong marshland

Ken Ying Kin So[1]* & David Dudgeon[2]

Introduction

The curved-back ricefish (*Oryzias curvinotus*) has been assessed as Data Deficient on the IUCN Red List. This small fish (maximum length 4 cm) is threatened in Hong Kong primarily due to habitat loss resulting from the large-scale abandonment of paddy farming in the 1970s. Introduction of the mosquitofish (*Gambusia affinis*), which occupies a similar ecological niche, has contributed to further declines in ricefish populations so that it is regarded as locally Vulnerable (Nip et al., 2014).

In 2014, a paddy-farming revitalisation programme was initiated at Lai Chi Wo (LCW) in the Northeastern New Territories of Hong Kong, southern China, where the ricefish had been extirpated. One programme objective was to restore paddy farming, with an emphasis on enhancing biodiversity. In line with this effort, the curved-back ricefish was reintroduced at LCW in 2017, adopting a framework based on IUCN guidelines.

Main Goals

1. *Trial release stage 1:* Determine if captive-bred ricefish can survive and reproduce in an enclosed environment (i.e. five field mesocosms) at LCW.
2. *Trial release stage 2*: Validate the use of environmental DNA (eDNA) techniques *for* future monitoring of ricefish abundance.
3. *Full-scale release stage 1*: Reestablish a self-sustaining population of curved-back ricefish in LCW.
4. *Full-scale release stage 2*: Use eDNA and field observations to monitor spreading of ricefish in paddy fields at LCW.

Success Indicators

1. *Trial release stage 1*: Mortality of <50% in each mesocosm, with gravid females and juveniles present.
2. *Trial release stage 2*: A relationship between eDNA concentration and number of ricefish established for use during future monitoring.
3. *Full-scale release stage 1*: There should be an annual increase in population size and occupancy of paddy fields at LCW.
4. *Full-scale release stage 2*: The reintroduced population should persist in the long term (i.e. >5 years).



In situ mesocosms in position for the trial release © Ken So

Project Summary

Feasibility

The curved-back ricefish usually forms schools near the surface of lentic or slow-flowing fresh waters habitats, such as paddy fields, ponds, and irrigation ditches. These man-made habitats can be easily restored. The Japanese medaka (*O. latipes*) has been extensively bred in captivity for experimental purposes, with a daily yields of 20 - 40 eggs per female under suitable conditions (Kinoshita et al., 2009). We demonstrated that wild-caught *O. curvinotus* were also amenable to captive breeding, so that it was straightforward to establish a founding population, bred from individuals from another Hong Kong marshland, for reintroduction at LCW.

Implementation

We reviewed relevant literature on the ecology, genetic structure and threats to ricefish during 2015, and identified potential source populations for individuals used for captive breeding and release. In October 2016, 38 ricefish from another wetland were used to establish a captive-breeding population. A water-storage channel at LCW was restored and enhanced to receive ricefish. In November 2017, 100 individuals were released into in situ mesocosms to assess survival and the feasibility of eDNA surveillance. The 91 surviving ricefish were released from the mesocosms in March 2018, together with 120 captive-bred individuals.

Post-release Monitoring

Monthly monitoring by visual counts and eDNA surveillance between May 2018 and March 2019 allowed assessment of the population growth and spread of ricefish in LCW. By March 2019, there were at least 1,550 individuals, with some spreading over 50 m from the channel. Monitoring frequency was reduced due to budget constraints, but visual counting took place every 2 months and eDNA surveillance twice a year between October 2019 and September 2021. Since then, only quarterly visual counts have been conducted. However, the ricefish population has flourished, with individuals seen more than 500 m from the release site.

Major Difficulties Faced

Biological

- *Ecological:* Conditions in the restored water-storage channel have deteriorated due to excessive growth of emergent plants.

Operational

- Adequate funding for long-term monitoring using eDNA surveillance has not been secured.
- The remote location of LCW increased the expense of post-release monitoring of ricefish.

Social

- Although education workshops and documentation have been organized, there has been limited engagement or participation in monitoring and habitat restoration by the local community.

Broad Underlying Problems

- *Suboptimal habitat:* Habitat degradation, including vegetation succession (or terrestrialization), of artificial fresh waters restored from abandoned agricultural land is challenging, requiring additional resources for management.
- *Other:* Engaging the local community and general public was difficult when the conservation target focused on non-charismatic and small freshwater fish.
- *Funding:* Since monitoring tends to be reduced or become unavailable as soon as the reintroduced population shows signs of stability.
- *Future uncertainty:* Long-term changes in the reintroduced population, or declines in habitat suitability, may remain undetected so undermining the success of the conservation intervention.

Major Lessons Learned

- The biology of congeners of the conservation target can be a valuable reference in the absence of detailed studies of the species to be reintroduced.
- It is important to allocate sufficient budget for habitat maintenance when undertaking reintroduction projects.
- Trial releases using in situ mesocosms can help indicate whether, during the initial post-release stage, reintroductions are likely to fail or succeed.
- In situ mesocosms are an important tool to establish the relationship between the abundance of the reintroduced population and eDNA concentrations, as well the environmental factors that may confound this relationship, so as to inform post-release monitoring of the reintroduced population.
- It is essential to secure a budget for long-term monitoring of the reintroduced population, even if the frequency of such monitoring is reduced over time.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- The trial release monitoring concluded with a 91% survival rate, and there was evidence of reproduction in the mesocosms.
- Specific primers had been developed for field detection of ricefish (So et al., 2020), allowing development of a predictive model for ricefish abundance based solely on eDNA concentrations, which explained 45.1% of the variance in population size.
- Downstream spread of ricefish from the release site was detected.
- Careful planning, preparation, and implementation which involved extensive literature review, on-site habitat

assessment and enhancement.

- The use of a in situ mesocosms allowed confirmation that the ricefish could survive at LCW prior to full-scale reintroduction.
- The absence of invasive mosquitofish at LCW meant that the ricefish reintroduction was more likely to be successful. There was another invasive poeciliid, the swordtail (*Xiphophorus helleri*), and removal control of its population was conducted in the early stage of release prior to the confirmation that it did not appear to interact with reintroduced ricefish.
- The project was made possible through collaboration involving the University of Hong Kong, the Conservancy Association (a local NGO), villagers at LCW, and the Hong Kong Government, with funding received from the Hong kong and Shanghai Banking Corporation Limited.

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Author Details

[1] Ken Ying Kin So, Outdoor Wildlife Learning Hong Kong, Kwai Chung, New Territories, Hong Kong, Kenso@owlhk.org*

[2] David Dudgeon, Division of Ecology & Biodiversity, School of Biological Sciences, The University of Hong Kong, Hong Kong, ddudgeon@hku.hk



The farming area of Lai Chi Wo (LCW) in Northeastern New Territories of Hong Kong, Southern China © Vito Tam



Reintroduction of Blanding's turtles within an urban landscape in Southern Ontario, Canada

Christine Drader*, Rachelle Fortier*, Toby Thorne & Rick Vos

Introduction

The Blanding's turtle (*Emydoidea blandingii*) is a globally endangered species, with population declines driven by habitat loss, direct removal, road mortality and increased predation (IUCN, 2010). These threats, along with long generation times and low natural recruitment, have resulted in slow population recovery across their range (IUCN, 2010). The Blanding's turtle population in the Rouge River Watershed (RRW) was deemed functionally extinct following extensive surveys in the early 2000s by the Toronto Zoo's Adopt-A-Pond Wetland Conservation Programme. The head-starting project outlined below aims to augment this historic population, to re-establish a sustainable population through the reintroduction of headstarted individuals for 20 - 25 years.

Since this project's inception in 2012, 669 juvenile Blanding's turtles have been released (429 head-started individuals, 240 non-headstarted hatchlings). Current population size was estimated at 321 (as of 2023), based on demographic data collected through post-release monitoring.

Main Goals

1. Re-establish a sustainable Blanding's turtle population in a historic part of their Ontario range.
2. Evaluate headstarting as a conservation tool for freshwater turtles, using metrics such as post-release survival rate, eventual mating, successful nesting, and hatching of eggs.
3. Fill knowledge gaps pertaining to the recovery and management of Blanding's turtles, by collecting critical data related to the species' behavior and habitat requirements.

Success Indicators

1. Release a minimum of 50, 2 year old headstarted Blanding's turtles at a 1:1.5 male-to-female sex ratio over a 20 - 25 year period.
2. Reach an adult Blanding's turtle population of 100 - 150 individuals by the year 2040.
3. Record evidence of headstarted turtles successfully overwintering and have similar survival and growth rates to wild turtles of similar ages.
4. Record evidence of headstarted turtles reproducing and increased natural recruitment across the population.



Adopt-A-Pond team at the release site in Toronto Zoo during 2023

Project Summary

Feasibility

Headstarting can be an effective tool to recover populations of species with relatively high fecundity, little to no parental care, and low juvenile survival (Heppell et al.,1996), which are life history traits exhibited by the Blanding's turtle. Upon identifying the habitat availability and requirements, a Population Viability Analysis (PVA) was first performed in 2013 to determine the number of juvenile turtles that should be supplemented. The PVA revealed that 40 - 50 headstarted turtles with a 1:1.5 male-to-female ratio must be released every year for 25 years to reach a sustainable population of 100 - 150 individual adult Blanding's turtles.

Implementation

Since 2012, Blanding's turtle eggs are collected yearly from a stable source population in Ontario and brought to the Toronto Zoo. Following incubation, hatchlings receive identification notches and upwards of 60 are kept for 2 years; excess hatchlings are released. Turtles in care receive varied diets adapted to meet their growing nutritional needs. Before release, juveniles receive Passive Integrated Transponders, and a random subset are fitted with radio-transmitters. In June, juveniles are released into suitable (i.e., shallow, low flow water, dense vegetation) wetlands in RRW. Every 3 - 5 years, an updated PVA is conducted to assess if further interventions are needed.

Post-release Monitoring

A subset of the head-started Blanding's turtles are tracked via radio-telemetry surveys upwards of three times a week in the active season (May - September) and once or twice a month in the inactive season (October - April). The focus of this work is to collect long-term data on turtle growth, activity, habitat choice, behaviour, movement, and how environmental factors may influence nesting, overwintering or other behaviour within the habitat. Additionally, mark recapture (2018 - 2020), trapping (2017 - 2021), nesting (2017 - current, excluding 2020), and road mortality (2017, 2018, 2021) surveys were conducted

to determine population level effects of all turtle species.

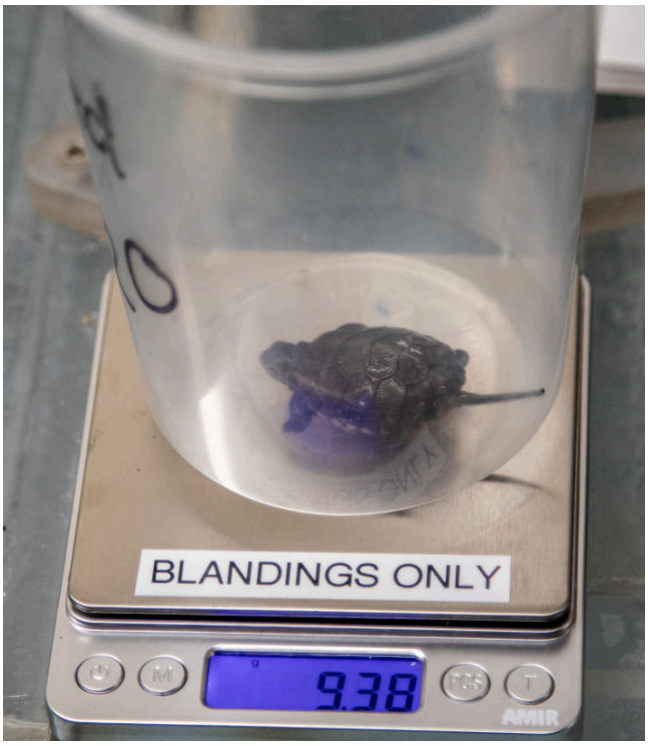
Major Difficulties Faced

Biological

- The life history traits of turtles (low recruitment, delayed sexual maturity, long generation time) make them highly sensitive to threats.
- An absence of wild juveniles/adults in RRW has made it difficult to collect demographic data for all age classes. This has led to difficulty when conducting accurate population demographic modelling/PVA.
- Predators (racoons, foxes, minks, etc.) are abundant in the area, influencing juvenile Blanding's turtle survival. A Mass Mortality Event (MME) occurred in 2020, which resulted in the loss of 48 juvenile Blanding's turtles (~26% of the total population at the time). The primary probable cause of mortality was depredation. While only one MME has been documented in the first 10 years of the project, depredation of turtles is common (particularly in the spring).

Operational

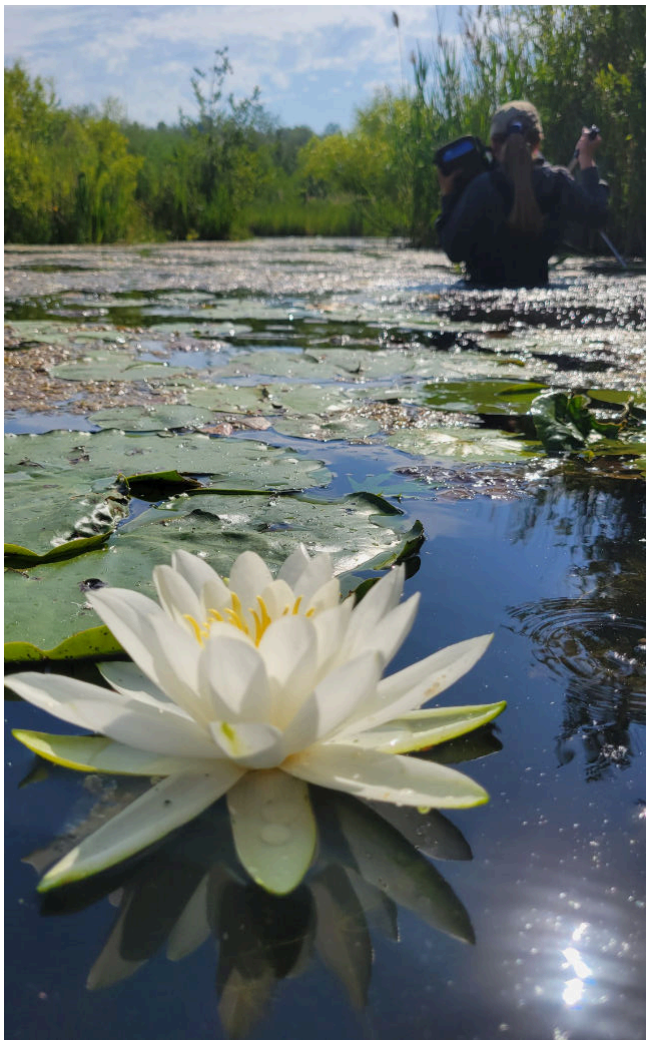
- This project is primarily supported by outside grant funding and donations. The amount and type of funding is often inconsistent from year-to-year. While we have been able to maintain the minimum required work for this project to continue, it has resulted in some constraints on the amount of data that can be collected and analysed. For example, limited funding for seasonal field staff has restricted the area that can be actively surveyed, so we may be missing observations outside of our active study area.
- For a long-term project like this, funding inconsistency and availability has been a limiting factor for staff levels, data collection and overall scientific research.



Blandings turtle on a weighing scale at Toronto Zoo

Broad Underlying Problems

- The main threats to turtles in Ontario are habitat loss and fragmentation, road mortality, subsidized predators, emerging diseases, and poaching, all of which are especially prevalent in urban landscapes.
- Urban development and habitat fragmentation reduces optimal environments and connectivity which are essential to the life history traits of freshwater turtle species. Additionally, government pressures to expand urban boundaries for future development have the potential to further reduce optimal habitat and connectivity.
- Climate events have increased the frequency and severity of drought conditions which can impact all life-history stages of freshwater turtle species.
- The introduction of non-native species such as European common reed (*Phragmites australis*) or red-eared sliders (*Trachemys scripta elegans*) into already limited wetland habitat in urban landscapes can reduce availability of resources to native freshwater turtle species.



Staff tracking released turtles in a pond

Major Lessons Learned

- This project has helped build knowledge on headstarting and release methods, including contributing to collaborative writing of the Standard Ontario Turtle Best Management Practices (BMP) document, currently in a draft stage.
- In the earliest reintroductions, the effects of hard release (i.e., directly releasing from in care to the wild) versus soft release (i.e. releasing into an in situ enclosure for a week before fully released into the wild) were tested. There were no differences found in survival or growth rate between hard release and soft release conditions (Wijewardena et al., 2023).
- Demographic modeling (population viability analysis) shows that juvenile mortality has the largest influence of population persistence and growth rates, while even small changes in nest, hatchling and adult survival will dramatically influence population trajectories and persistence. Therefore, continued adaptive management to reduce mortality (i.e., protection of nests, predator management, road mortality mitigation etc.) will be needed to maintain this population over time. Population demographics from this project can be used as a baseline for future analyses for freshwater turtles in other urban landscapes.
- Continued long-term monitoring and adaptive management of conservation actions will be critical in ensuring the success of this head-starting programme. Following release, the head-started turtles can undergo unpredictable post-release challenges affecting the population at large (e.g. MMEs, changes to suitable habitat, etc.). Adaptive management, supported by the most current PVA, can account for these post-release challenges to ensure reintroduction goals are met. Additionally, long-term monitoring is especially important in species with long generation times and low natural recruitment.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- Head-starting efforts have increased the total population size.
- Head-started turtles have been seen to overwinter successfully (Ritchie, 2017).
- We were unable to directly compare survival and growth rates between head-started and local wild juveniles due to low recapture rates in local Blanding's turtle populations. However, head-started turtles sustain similar health metrics as similar-sized wild juveniles in other Ontario populations (Wijewardena et al., 2023).
- Since the population is so young, there are still many unknowns about

demographic parameters such as age of first reproduction, precent of females breeding, nest success, and hatchling survival. Once head-started individuals begin to reach a reproductive age, we will know more about overall success of the project and gain more accurate demographic data to better inform future population modelling.

- No wild-hatched neonate or juvenile turtles have been seen in the study area since this project began, making it difficult to build meaningful comparisons on survival, behaviour, habitat use and movement.

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Author Details

[1] *Toronto Zoo, 361A Old Finch Avenue, Toronto, Ontario, M1B 5K7, Canada,*
[*] *cdrader@torontozoo.ca*
[*] *rfortier@torontozoo.ca*
tthorne@torontozoo.ca
rvos@torontozoo.ca

[*] *These authors contributed equally*





Reintroductions of Orinoco crocodiles in Eastern Colombia

Rafael Antelo[1]*, Luz Dary Acevedo-Cendales[2], Carlos Saavedra Rodríguez[2], Leonor Valenzuela[2] & Germán Forero Medina[2]

Introduction

The Orinoco crocodile (*Crocodylus intermedius*) is the largest continental predator of the Americas. It is restricted to the lowlands (<300 m a.s.l.) of the Orinoco River basin, in Colombia and Venezuela (Medem, 1981). A 30-year period of commercial hunting depleted the formerly exuberant crocodile populations across its range (Medem, 1958; Mondolfi, 1965). It is listed as Critically Endangered (A2bcd; C2a(i)) by the IUCN (Balaguera-Reina et al., 2018) and included in Appendix I of CITES.

The National Programme for the Orinoco Crocodile Conservation in Colombia, launched in 1998 by the Environmental Ministry, The Humboldt Institute and the National University of Colombia, includes among its strategies captive-breeding programmes, identification of potential habitats for reintroduction, the development of a reintroduction protocol, and monitoring of the released individuals.

Here we report the results of the reintroductions conducted as part of the national programme in the Llanos region in Casanare, Arauca, and Vichada departments from 2015 - 2019.

Main Goals

1. Prevent the extinction of the Orinoco crocodile in Colombia and promote its recovery in its range by establishing new populations in areas where it was extirpated.
2. Improve the area and infrastructure of captive breeding facilities.
3. Elaboration and gazettement of a reintroduction protocol by the environmental authorities.
4. Identification and assessment of reintroduction sites.

5. Define health parameters to assess crocodiles for release purposes.



Caiman partners with a tagged individual for release © María Torres Martinez.

Success Indicators

1. Number of captive breeding facilities for the species.
2. Number of suitable sites identified for the reintroduction of captive-bred crocodiles.
3. Reintroduction protocol adopted by the environmental authorities.
4. Health parameters defined and measured to assess crocodiles for release purposes.
5. Number of released crocodiles established in the reintroduction areas.

Project Summary

Feasibility

The Orinoco crocodile is a freshwater species that inhabits the Llanos region in Colombia and Venezuela. The captive breeding programme of the species started in Colombia in 1970 at the Roberto Franco Tropical Biological Station (RFTBS). In 2002, a new breeding centre was established at Wisirare Biopark (Orocué, Casanare). Since 2012 it has been run by the Palmarito Foundation and with the collaboration of the Wildlife Conservation Society (WCS), National Parks of Colombia, the regional environmental authority (CORPORINOQUIA), and other institutions, the first conservation results were achieved.

Implementation

In 2014, the Protocol for the Reintroduction of the Orinoco Crocodile in the Natural National Parks of Colombia was adopted, following IUCN guidelines. Crocodiles' health was evaluated prior to release, considering physiological parameters, complete blood count, blood chemistry, gastrointestinal bacteria, and parasites (gastrointestinal endoparasites, ectoparasites, and hemoparasites). From 2015 - 2019, 217 captive-bred sub-adult crocodiles (median total length and weight=101.3 cm and 2,719.8 g) were released in privately protected areas (PPA) (54%), national parks (NP) (33%), and unprotected areas (13%). They were released as follows: El Tuparro NP (71 individuals), La Aurora PPA (32), Cravo Norte River (29); Corozito PPA (20); Palmarito PPA (25) and Hato Venecia PPA (40).

Post-release Monitoring

To monitor the movements post-release and survival rates, 67 individuals were fixed with transmitters (57 VHF and 10 satellites) set to last for 1 year, but in two cases, they stopped working significantly before their designed lifespan. Additionally, the last 30 crocodiles released at El Tuparro NP could not be radio-tracked due to COVID-19 restrictions. At La Aurora PPA, the survival rate for 309 days of 5 crocodiles was estimated to be at least 60%; at El Tuparro NP, the survival rate during the first year of a cohort of 12 radio-tracked crocodiles was at least 50%. In both sites, the crocodiles remained inside the protected areas.



Caiman habitat at the release site

Major Difficulties Faced

Social

- To find protected areas inside the species´ range with low human densities and/or where the local communities accepted the reintroduction of such a large predator.

Operational

- Monitoring released crocodiles was a challenge due to the malfunction of transmitters and the long distances traveled by the crocodiles in remote areas like El Tuparro NP.
- There are no laboratories with standardised tests to analyse pathogens in crocodiles in Colombia.

Legislative

- After 18 years of inaction, the major challenge was to convince environmental authorities that all the legal and technical conditions were in place to initiate the reintroduction of captive crocodiles.

Broad Underlying Problems

- The so far inexplicably slow recovery of the species. More than 50 years have passed since commercial hunting ceased and there is still little sign of natural recovery. Competition with the sympatric spectacled caiman (*Caiman crocodilus*) could be an explanation but is not proven.
- The local populations' fear of the species makes it difficult to find release sites. This is perhaps due to the time that has elapsed without living with the species.

Major Lessons Learned

- The state is not able to implement the National Programme on its own. To achieve this goal, it is necessary to have close collaborations between public and civil society actors: communities, NGOs, academia, and companies.
- The most outstanding results were achieved at La Aurora PPA, probably because it is the place where the larger crocodiles were released (mean 120 cm total length). We suggest increasing the minimum size of the individuals to release.
- Communities that are used to living with historical crocodile populations are less fearful than those that have not been living with the crocodiles for 1 - 3 generations. In the latter, exaggerated stories remain about the danger of the Orinoco crocodiles. It is necessary to work on human-crocodile coexistence practices.
- The probability of post-release capture is very low, so it is necessary to make complete a clinical diagnosis as possible, considering complete blood count, blood chemistry, and infectious agents.
- There is only one record of a reintroduced crocodile dying, possibly due to injuries caused by a spectacled caiman (*Caiman crocodilus*) at Corozito

PPA; there are no records of crocodiles being killed by humans.

- Differences in movements change dramatically depending on the ecosystem, with crocodiles traveling longer distances in lentic waters than in lotic waters.
- The onset of the rainy season and the rising levels of the river encourage crocodile dispersion from the liberation area.
- Crocodiles tend to remain in the protected areas where they are released.
- First data suggests that the reintroduction of captive-bred individuals combined with the awareness of local communities can prevent the extinction of the Orinoco crocodile and promote its recovery in its range.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- A national protocol was defined and adopted officially by public and private entities.
- The collaboration and commitment of different entities have allowed constant financing for 10 years from private companies such as Grupo Hoteles Limitada (GHL), Ecopetrol, public institutions (Environmental authorities) such as CORPORINOQUIA and Natural National Parks and civil society (WCS, Palmarito).
- The implementation of Wisirare Biopark as a new breeding center increased the rates of crocodiles available for reintroduction.
- The reintroduction of more than 200 crocodiles into the wild represents 72.3% of the total population estimated for Colombia (around 300 individuals).
- The support of private owners and local communities for the conservation of the Orinoco crocodile.

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Author Details

[1] WWF, Bolivia, rantelo78@gmail.com*

[2] Wildlife Conservation Society,
ldacevedo@wcs.org
csaavedra@wcs.org
lvalenzuela@wcs.org
gforero@wcs.org



Reintroduction of tuatara to a cool-temperate mainland sanctuary in south-eastern Aotearoa, New Zealand

Scott Jarvie[1],[2]*, Anne Besson[2], Lyn Carter[3], Jade Christiansen[2], Jemima Gardiner-Rodden[2], Stephanie Godfrey[2], Noela McGregor[4], Nicola Nelson[5], Ricardo Mello[2], Philip Seddon[2], Elton Smith[6] & Alison Cree[2]

Introduction

Tuatara (*Sphenodon punctatus*; the only living rhynchocephalians) constitute an iconic reptile species endemic to Aotearoa New Zealand (NZ). Once widespread, tuatara became restricted to offshore islands following human arrival and the introduction of predatory mammals. Tuatara are listed in the IUCN Red List as "Least Concern" and in NZ's Department of Conservation (DOC) Threat Classification System as "At Risk–Relict". In 2012, 30 adult and 57 juvenile tuatara were reintroduced to Orokonui Ecosanctuary (hereafter Orokonui; Te Korowai o Mihiwaka), a 307 ha mainland sanctuary in south-eastern Te Waipounamu South Island (Cree, 2014). A reinforcement with 18 juveniles followed (2016 - 2017). Adults and 14 juveniles from the initial release were wild-caught; remaining animals were captive-reared. The release followed guidelines from DOC's Tuatara Recovery Plan (Gaze, 2001) after consultation with Ngāti Koata iwi and Kāti Huirapa Rūnaka ki Puketeraki.

Main Goals

1. To reinstate tuatara as a component of a healthy ecosystem in an area of their prehuman range, in this case in southern NZ.

2. To promote public awareness of tuatara and related conservation issues.

3. To research factors that improve translocation success, including the influence of source (captive vs. wild), as well as nesting behavior in a cooler

location than the currently inhabited range.



Tuatara with Noela & Scott © Ricardo Mello

Success Indicators

1. Between Years 5 - 6 after release, 50% of the adults released should be re-sighted and evidence of breeding confirmed (e.g., observation of at least 2 - 3 unmarked, young animals).

2. At about Year 10, from a sample of 30 - 35 animals, the percentage of small tuatara in the sample (i.e., juveniles or sub-adults bred on-site relative to the total including adults at release) should be sufficient to indicate that either the population has established (≥20%), or that the population has not established but that prospects for establishment are considered satisfactory (10 - 19%). A smaller percentage of juveniles in the total sample (<10%) would be cause for concern and warrant further investigation.

3. These staged indicators were based on recommendations from the Tuatara Recovery Group to provisionally assess, within the first decade, the success of a translocation within the existing geographic range of tuatara. Given the more southerly (cooler) location of Orokonui outside the relict distribution, slower demographic responses were anticipated.

4. The long-term goal is to establish a self-sustaining population of tuatara at Orokonui.

Project Summary

Feasibility

Tuatara were released into Orokonui, a fenced sanctuary, with introduced mammals eliminated except house mice (*Mus musculus*, which is controlled). This first free-release to the South Island is outside the relict distribution, but within the indigenous range of the genus. The source population on Takapourewa (Stephens Island), ~570 km north of Orokonui, is large and genetically diverse. The release was authorised by DOC following consultation with Ngāti Koata, kaitiaki (guardians) of Takapourewa tuatara, Kāti Huirapa Rūnaka ki Puketeraki, mana whenua or people with ancestral relationships with the land at the recipient site, and Otago Natural History Trust who manage the sanctuary.

Implementation

Tuatara were free-released in 2012: wild adults and juveniles direct from Takapourewa (15 males; 15 females; 14 juveniles) and captive-reared juveniles from Orokonui (15) and Ngā Manu Nature Reserve, ~480 km north of Orokonui (28). Reinforcements of captive-reared juveniles took place in 2016 - 2017 (18). Captive-rearing facilities were pens with semi-natural conditions.

At release tuatara were weighed and measured, then placed into artificial burrows. Ticks (*Archaeocroton sphenodonti*; threat status “At Risk–Relict”) and mites (*Neotrombicula* spp.) on wild animals were

left attached. All tuatara released in 2012 had passive integrated transponder (PIT) tags inserted for identification, whereas reinforcement juveniles released were only photographed.

Post-release Monitoring

Monitoring focused on warmer months, using radio-telemetry in the 5 months post-release, active searches, retreat searches with a burrowscope, and trail cameras for nest sites. The initial focus has been tuatara released in 2012, because of their larger size and ease of safe monitoring. Nest monitoring had a greater focus in later years.

High survival rates and growth of all groups of juveniles were recorded in the first summer (Jarvie et al., 2015, 2016). Between Year 5 - 6, 56.7% of individuals released as adults were observed (10 males=66.7%, 7 females=46.7%) and 28.1% of those released as juveniles. During Year 11, 63.3% of individuals released as adults were observed (10 males=66.7%, 9 females=60%) and 42.1% of those released as juveniles. Although juveniles from all release groups in 2012 are reaching adult size, wild-released juveniles are being observed more frequently. Although Year 11 night searches and burrowscoping did not reveal evidence of juveniles or subadults produced on-site, at least 10 nests have been detected since 2012 and at least 10 unmarked, young animals (mainly hatchlings near nesting areas) have been confirmed in other monitoring since 2020.

Major Difficulties Faced

Biological

- Finding released juveniles is challenging. Radio telemetry was effective in evaluating survival of juveniles in the short-term, but this method is impractical in the long term. The use of a burrowscope to search retreat sites increased detection probabilities.
- Finding evidence of recruitment, i.e., hatchlings and juveniles produced on-site, is extremely challenging. Monitoring methods included trail cameras to monitor nest sites, deployment of artificial cover objects near nesting areas, and active searches. Although nesting attempts are observed in most years, some nests are unsuccessful and the number monitored to completion is low. The recording of individuals hatched on-site over more than one year is also low, with none of these Orokonui-hatched individuals known to have reached large juvenile or sub-adult size, possibly due to low detection probabilities.
- House mouse presence inside the sanctuary has unknown but potentially negative effects on tuatara, especially smaller individuals that they may compete with or predate on.
- Incursions of larger introduced predatory mammals have occurred, including by ship rats (*Rattus rattus*) and stoats (*Mustela erminea*), and continued invasive mammal surveillance and elimination is required.
- Some tuatara have lost their PIT-tags. Identification of individuals using natural markings or other features could be used for monitoring for several years but is untested in the long term (Mello et al., 2019).

Operational

- Responses to the COVID-19 pandemic limited access to Orokonui for monitoring at times.
- Orokonui is largely dependent on external researchers for detailed monitoring of tuatara, and availability of researchers fluctuates.

Broad Underlying Problems

- Limited options for control of the house mouse at Orokonui (and in other mainland sanctuaries in NZ), with no current option for eradication.
- Recurrent risk of reinvasion by introduced predatory mammals, including rats and stoats.

- Tension for sanctuaries between prioritizing reintroduction of large charismatic endotherms (including potential native predators), versus re-establishing food webs at lower levels or with species performing important ecosystem roles (e.g., burrowing seabirds, which are ecosystem engineers with benefits for tuatara, have yet to be reintroduced to Orokonui).



The adult release area - 5th April 2013
© Alison Cree

- Uncertain financial viability of sanctuaries, including in the post-COVID environment with reduced income from tourism.
- Climate change brings risk: although warming temperatures might bring short-term benefits for tuatara (e.g., increased nesting, egg-incubation success and/or growth rates), other changes may be adverse (e.g., increasing frequency and intensity of extreme weather events, potential risks of fire).
- Long-term commitment is required to maintain the ecosanctuary fence and monitor a long-lived and late-maturing species.

Major Lessons Learned

- Even more than with previous reintroductions of tuatara, measuring post-release population responses in a cooler climate requires long-term commitment. In the source population, tuatara have great longevity (>100 years), slow maturation (≥10 years), and low productivity (clutch size ~10 eggs, nesting every ~4+ years). The cooler temperatures at Orokonui could be contributing to slower population growth than seen at other translocation sites.
- Differences in life-stage detection probabilities should inform monitoring. As hatchling and juvenile tuatara have lower detection probabilities than adults, surveys for evidence of recruitment will be more productive if they take place when offspring produced on-site have had more time to reach sub-adult or adult size.
- The source of tuatara (captive vs. wild) had minimal impacts on survival post-release, although monitoring in recent years suggests more frequent observations of wild juveniles, relative to number released, than for captive-reared individuals.
- Growth of native vegetation in the reserve has the potential to shade some nesting areas. This could affect egg-incubation success and the sex ratios of offspring (tuatara have an unusual form of temperature-dependent sex determination in which males are preferentially or solely produced at higher temperatures).
- Factors contributing to egg incubation success (potentially including cool temperatures and interference from native species) and hatchling/juvenile survival (potentially including predation by native species and introduced mice) merit ongoing research.

- Ectoparasites have variable persistence. Trombiculids have not persisted post-release, while ticks remain, but on fewer individuals and at lower abundance by Year 11 than at release. Transmission of ticks from wild-sourced animals to captive-reared individuals has happened.

- The involvement of iwi in the reintroduction of tuatara has created kaitiakitanga opportunities (inherited responsibilities and obligations through the active expressions of caring for, protecting and safeguarding) for tangata whenua (indigenous communities) and kaitiaki (guardians and protectors).

- Public interest in the reintroduced population of tuatara at Orokonui remains high. Tuatara feature in popular articles, newspaper reports, educational and outreach programmes, and peer-reviewed publications. Due to the release site being in a cooler climate than previous translocations, this population is discussed as an insurance population in the context of human-induced climate change.

- The joint commitment of sanctuary staff and volunteers, university staff and students, a government department, and kaitiaki was critical to this major conservation achievement. Ongoing communication and cooperation among stakeholders will enhance the prospects for long-term reintroduction success.



Adult male tuatara at release © Scott Jarvie

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- Goals 1 - 3 have been essentially achieved (although mice - not a component of a healthy native ecosystem in Aotearoa New Zealand - are still present).

- Success Indicator 1 has been achieved. Tuatara are clearly surviving and growing in body size at Orokonui, and some nesting and recruitment is taking place. Although the percentage of new juveniles in the Year 11 survey did not meet the expectation of Success Indicator 2, it is unclear whether juvenile tuatara at this cool location simply require more time for to grow large enough to be easily detected, or whether recruitment is being inhibited by other factors.

- Although these provisional results are encouraging, the slow life history of tuatara is such that even under ideal conditions, decades could be required to achieve the long-term goal of a self-sustaining population.

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Author Details

[1, 2] Scott Jarvie, Terrestrial Ecologist, Otago Regional Council, Dunedin 9016, Aotearoa New Zealand, sjarvie@gmail.com*

[2] Anne Besson, anne.besson@otago.ac.nz

[2] Jade Christiansen, jade.christiansen@wildlands.co.nz

[2] Jemima Gardiner-Rodden, jrodden@doc.govt.nz

[2] Stephanie Godfrey, stephanie.godfrey@otago.ac.nz

[2] Ricardo Mello, ricardosrm@gmail.com

[2] Philip Seddon, philip.seddon@otago.ac.nz

[2] Alison Cree, alison.cree@otago.ac.nz

[3] Lyn Carter, lyncarter880@gmail.com

[4] Noela McGregor, noela_13@hotmail.com

[5] Nicola Nelson, nicola.nelson@vuw.ac.nz

[6] Elton Smith, elton@orokonui.nz



Reestablishing a population of the Negros bleeding heart dove on Negros Island, Philippines

Justine Magbanua[1]*, Matt Ward[1], Ysabella Ward[1], Fernando Gutierrez[1], Monica Atienza[1], Edward Pelter[1], Spencer Smith[1] & Joe Wood[2]

Introduction

The Negros bleeding heart dove (*Gallicolumba keayi*) is a critically endangered dove species endemic to the West Visayan Faunal Region of the Philippines. It is restricted to the islands of Negros (study site) and Panay with populations at a critical low. Although protected by national law, this species suffers greatly from habitat loss, poaching and invasive threats.

The reintroduction of this species was conducted in the Bayawan Nature Reserve in southwest Negros, after a conservation planning workshop with multiple experts identified reintroductions as a suitable method for restoring populations in extirpated areas.

The reintroduction is made possible with the funding and support of Toledo Zoo and their experts in pigeon and dove conservation. Toledo Zoo are the exclusive advisors and financial supporters to this project and are dedicated to aiding Talarak in the restoration of this species.

Main Goals

1. Establish a population of Negros bleeding heart doves into the Bayawan Nature Reserve.
2. Promote breeding and population increase from the reintroduced population.
3. Learn missing information about the natural history, ecology and behavior of the Negros bleeding heart doves within the nature reserve, using camera traps and telemetry observations.
4. Determine longevity and space-use of released individuals in a natural setting.

Success Indicators

1. Confirmed breeding success (nesting to fledging) from at least one pair within the first 5 years.

2. Maximum of 20% original population loss through mortalities within the first 2 years.

3. Animals show natural behavior within 3 months post release, foraging naturally, establishing home-ranges, and interspecies interactions.

4. Natural social structures are adopted by the released individuals as they adapt to the wild.



Tracking bleeding heart doves through their natural habitat

Project Summary

Feasibility

The release area is a 300 ha fenced reserve composed of young secondary forest and plantation forests. The species was only previously known to inhabit lowland (under 600 m elevation) primary growth forests in the islands of Panay and Negros. It is suspected the doves prefer closed canopy forest with open understory as areas for foraging and roosting. As a ground dwelling dove they spend most of their time foraging on the ground for seeds, invertebrates and fallen fruit/berries. Their social structures and behaviours are unknown from the wild.

Implementation

From our captive breeding stock at the two Talarak conservation centres on Negros Island, 18 individuals were selected for release into the Bayawan Nature Reserve. The first 8 individuals were released as pairs, with a desire to match personalities tested in the aviaries, to create naturally bonded individuals in the soft-release aviaries in the reserve. After limited success with this technique, the remaining 10 individuals were released as a cohort. This release strategy allowed for communal organisation in a larger soft-release aviary, natural bonding with more opportunities for mate selection, and has shown increased survivability. At present 4 of the 10 cohort released individuals are still being monitored 1 year post release, with most others losing their transmitters or leaving the reserve. Before release all animals were equipped with VHF radio-transmitters and tracked at least twice daily to record observable behaviours, dispersal, conspecific grouping, health and welfare, and roosting locations. These observations have highlighted a lot of novel inter-specific and intra-specific behaviours, identified ranging patterns, habitat preferences, and led to the discovery of natural breeding events

Post-release Monitoring

VHF tags were used to track individuals for behaviour and monitoring but unfortunately we faced several problems with regards to the attachment method. We used several designs for transmitter attachment but currently only one iteration seems to be working, which we will be publishing for future reference and dove research projects. Early concerns around habituation or stressing the birds through regular tracking were eased, as the diurnal tracking

maintained adequate distance to get observations but avoid disturbance, and nocturnal tracking had no effect on the birds natural behaviour.

Major Difficulties Faced

Biological

- With our founder generation only coming from three individuals we are constantly trying to maintain clean genetic lines and suitable breeding pairs. These animals have also been maintained in captivity for 30 years with multiple generations being bred and maintained. We have no idea how these factors would implicate future breeding success or survival traits, but this is the most likely opportunity to learn and develop release procedures to restore the species.

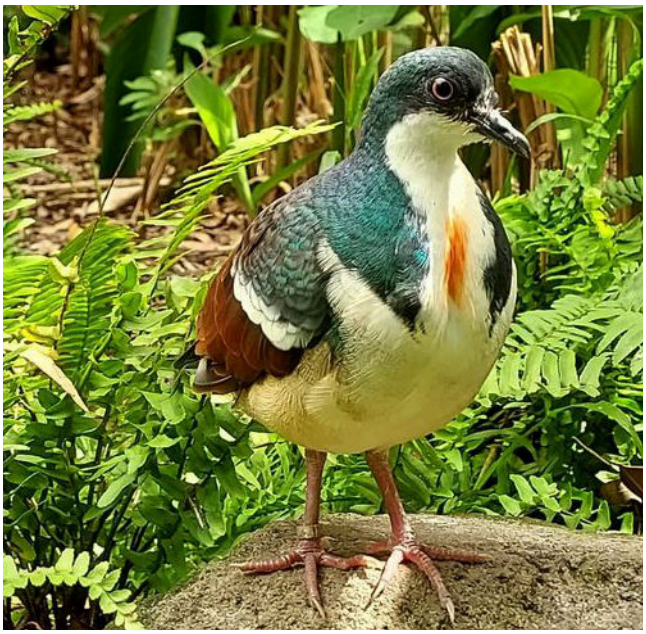
Operational

- As this is the first time a species has been reintroduced, we have had to do all sorts of initial work regarding the reintroduction and monitoring procedure. One important aspect was that we had to design a novel harness attachment method for the installation of the VHF tags. We had several designs for the harness that we tested out but only one seemed to work.

- These animals are only found in Negros and Panay and have only been known to inhabit lowland primary forests. We decided to release them within this young secondary forest to see if they would be able to adapt to a different kind of habitat, as this is the only opportunity to restore the species given the major habitat loss within their range.

Social

- Hunting for sport is a prevalent issue on Negros but also throughout the Philippines. This has led us to intensify our Information, Education and Communication (IEC) campaign with our education team leading community engagement and education activities for 2 years prior to animal release.



Bleeding heart dove on forest floor

Broad Underlying Problems

- *Unavailable habitat:* Mass deforestation during the 20th century lead to the disappearance of 95% of the primary forests on both Panay and Negros islands. Some forest restoration has been conducted, alongside protection of habitats in Protected Areas, however these are often degraded secondary forest landscapes.

- *Hunting pressure:* Local communities often hunt for sport as part of the culture. This includes mammals and reptiles (often eaten afterward) but predominantly the careless shooting of birds with airguns, home-made guns, and catapults.

- *Lack of knowledge:* As this species is endemic to only two islands, and incredibly rare to find within either island now, there is a severe lack of ecological, habitat use or demographic data. Previous expeditions focused entirely on population identification but even those are now outdated with many formerly known populations now extinct. Most of our activities are guided by anecdotal reports, similar species, or learnings from captive sources.

Major Lessons Learned

- Initial attempts at releasing young pairs proved inefficient as many times one of the pair would succumb to natural predation within the first few weeks, leaving the other alone for prolonged periods. Attempts to repair these individuals or identify optimal pairs in captivity was also not promising. With the help of Toledo Zoo advisory support, we were able to conduct cohort releases, which showed significantly improved survival and bonding between individuals.

- Adjusting for initial identification as rats and cats being major predators, we built taller aviaries with taller perches for the birds to roost at night. These taller perches were directly replicated post-release with higher roosting at night in the trees, and predation rates dropped significantly.

- We initially used a a sympatric species, the grey capped emerald dove, to act as a reference for natural diet, habitat and ecological requirements of the Negros bleeding heart doves within the reserve. This appeared to be suitable as these species are seen overlapping in ecology, with the bleeding heart dove frequently chasing the emerald dove out of foraging locations.

- Through trial and error we were able to determine the most efficient harness design for attaching VHF tags to this species. Identifying problems with collar mounts (center of balance is severely impacted) and tail or foot mounts (as a terrestrial “ground dove” the bird walks a lot and lower mounted devices get caught in undergrowth or foliage).

- We have observed a variety of intriguing behaviors since their subsequent transfer to the soft release enclosure and into the wild. Including intriguing social behaviors to establish hierarchies and create social order, but also interspecific competition and survival threats.

- We have observed that whilst this species could be predated or threatened by numerous species within these habitats, it appears as though rats are the predominant predator, with cats second. After adjustment periods and anti-predator trainings, the birds seem able to survive snakes or other larger predators, however nocturnal predation by rats appears to be a major threat.

- Constant information and education campaigns and community engagement have worked well to mitigate hunting pressure around the reserve. We are aiming to make the bleeding heart dove an ambassador of the reserve and the local area, which has received positive reception from the community and the species is already becoming a celebrity.

- The telemetry tracking of the birds allows for accurate monitoring of survival, health and ecology. However using VHF in the dense tropical forests is physically demanding and hampered by rain. Two individuals had fled the reserve during rainy periods where the tracking team could not keep up with them and eventually lost contact (listed as mortalities but no confirmation of status).

- The telemetry tracking of the released individuals highlighted varied behavioural responses and adaptability to the new environment and presence of other bleeding hearts within aviaries at the site. Some individuals settled quickly and established ranges, with social interactions amongst released and captive birds, whereas others fled the reserve possibly after negative interactions with conspecifics or fear of persecution from dominant individuals within the captive aviary. Further investigation is needed to try and profile suitable birds for releases.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- Proposed goals of the study were partially reached:
    - Natural behaviors were observed with some individuals showing successful adaptation to these secondary forest habitats over prolonged periods of

time (being able to forage, avoid predation and find shelter on their own).

- Social behaviors between individuals within the soft-release aviaries and post release have been observed to be natural. These individuals appear to show a more natural social ecology than animals within breeding aviaries at the conservation centers.

- A total of 18 birds have been released since the start of the project in 2022. Of these 18 birds, several individuals have survived more than 1 year, with daily tracking documenting their everyday movements and behaviours. Those birds lost in the study have been through natural predation, although this has largely been reduced with the increase in anti-predator training and soft-release aviary design. The primary concern with the programme is the loss of information and tracking ability on individuals if they move great distances from the release site (occurred in 3 occasions) or their transmitters run out of battery before being recaptured for new devices (occurred 8 times). At present the study is still actively monitoring 4 individuals who have been tracked for 1 year each, with at least 2 further birds to be observed in the area regularly without their VHF transmitters.

- Almost all mortalities were due to natural predation by rats, one predation by a cat (suspected invasive domestic cat) and two birds have been declared mortalities although they fled the reserve and their status is unconfirmed.

- Breeding has been observed several times within the soft release aviaries with no success of nesting. However the released individuals have been identified to bond and produce a viable nest within the first year of release. Unfortunately this nest was not successful, however the adult pair were able to create a natural nest with the environmental materials around, lay viable eggs with one individual hatching, and rear that individual almost to fledging, until extreme weather events caused the nest to fail. These are all major indicators of success for a species originating from several generations in captivity, non-paired and inexperienced prior to release, and in habitats which are suspected by some as unsuitable given the current data on the species only in primary forests.

Acknowledgements

We would like to acknowledge the unwavering support from Toledo Zoo in our reintroduction efforts for the Negros bleeding heart dove. Toledo are supporting this project financially and advisory across all areas of the project's implementation, from aviary design, transmitter attachment, bird handling, and tracking process, as well as supporting the hiring of several local staff members in the tracking, husbandry, and education components.

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Not available.

Author Details

[1] Justine Magbanua, Talarak Foundation Inc., Negros Forest Park, Bacolod City, Negros, Occidental, Philippines 6100, talarakconservationteam@gmail.com*

[1] Matt Ward

[1] Ysabella Ward

[1] Fernando Gutierrez

[1] Monica Atienza monicamarie

[1] Edward Pelter

[1] Spencer Smith

[2] Joe Wood, Toledo Zoo, 2 Hippos Way, Toledo, Ohio, United States of America, 43609, Joe.Wood@toledozoo.org



Multi-site reintroduction of the bush stone-curlew in south-eastern Australia

Shoshana Rapley[1]*, Kate Grarock, Chris Davey, Belinda A. Wilson[1], Heather McGinness[2], Maldwyn J. Evans[1], Iain J. Gordon[1,3], Robert Heinsohn[1], Joel Patterson[4], Simon Stratford[4], Jenny Newport[1], Dale Crisp[5], Annette Rypalski[5], David Shorthouse & Adrian D. Manning[1]

Introduction

The bush stone-curlew (*Burhinus grallarius*) is a medium-sized bird that formerly occurred across the Australian continent. They are a nocturnal mesopredator and roost during the day among woody debris with their cryptically camouflaged plumage. They are cursorial and ground-dwelling but can fly.

The species' original decline was driven by habitat destruction and predation by invasive species (particularly red foxes). The species is listed as Critically Endangered in Victoria, Endangered in New South Wales, and Extinct in the Australian Capital Territory (ACT) since the 1970s. They are listed as Least Concern by the IUCN because declines occurred prior to the last three generations and the species is considered secure in northern Australia.

This reintroduction project was first implemented in the ACT and later expanded to Victoria. Reintroduction planning used the 2013 IUCN Guidelines and the Translocation Tactics Classification System (Batson et al., 2015). The project took place on Ngunnawal, Ngambri, Wathaurong, and Dja Dja Wurrung Country.

Main Goals

1. To establish populations at the release sites.
2. To develop translocation tactics for the species.

Success Indicators

1. *Survival:* ≥50% of released individuals surviving after 90 days post-release (note: all survival % reported hereafter is to 90 days).
2. *Reproduction:* Breeding one-year post-release.
3. *Additional success criteria to be monitored in the long term:* Population growth and persistence, and genetic and behavioral diversity.



Bush stone-curlew destined for release
© Annette Ruzicka

Project Summary

Feasibility

The project commenced in 2013 with development of a translocation plan, endorsed by key stakeholders. We identified Mulligans Flat Woodland Sanctuary (MFWS) as a feasible site for reintroduction due to appropriate habitat, predator exclusion fencing, and organisational experience in translocation. MFWS and the adjacent Goorooyarroo Nature Reserve (GNR) are the site of a long-term ecological restoration project (Shorthouse et al., 2012; Manning et al., 2011) including experimental restocking of coarse woody debris (large logs - a key habitat requirement for the bush stone-curlew) and multi-trophic reintroduction. These projects were conducted by a partnership between the Woodlands and Wetlands Trust, the Australian National University (ANU; https://www.coexistenceconservationlab.org/) and the ACT Government, with support from the Canberra Ornithologists Group (https://canberrabirds.org.au/) and the local community. Mulligans Flat Woodland Sanctuary and GNR are bordered by suburbs to the west and an agricultural matrix to the east.

Following success at MFWS, we expanded the programme to Mt. Rothwell Reserve (MTR) and Orana Sanctuary (OS) in Victoria as a partnership between the ANU and the Odonata Foundation (https://odonata.org.au/). Mt. Rothwell Reserve and OS are bordered by an agricultural matrix with remnant woodland.

Implementation

We translocated adult, captive-bred bush stone-curlews of equal sex ratio to four fenced sanctuaries:

- 67 individuals to MFWS in 2014 - 2022,
- 25 individuals to MTR in 2022 - 2023,
- 21 individuals to OS in 2023, and
- 16 individuals to GNR in 2021.

In 2014 - 2019, we used a soft release tactic (founders held in a custom-built aviary for an average of 112 days). We switched to hard release in 2022 using a drip-feed tactic (see *'Major Lessons Learned'*).

From 2015 onwards, we used a wing-clipping tactic to prevent hyper-dispersal over the fence. Before wing-clipping survival was 27%, and after wing-clipping rose to 80% in 2015 and 74% in 2016. Survival was 60% at MTR, with wing-clipping. We did not use wing-clipping in 2022 at MFWS to allow

the translocated individuals to maintain social groups with established birds that had flight capacity; survival was 64%.

The GNR translocation in 2021 was suspended due to predation by a red fox that was not detected inside the fence prior to translocation; the surviving birds were returned to captivity. Natural emigration (i.e., by the birds, not due to translocation) from MFWS has now resulted in a breeding population at GNR.

For the OS translocation in 2023, we trialled a stepping-stone tactic where we first translocated half of the birds to MTR for 8 weeks alongside established conspecifics (treatment cohort, 90% survival), while the remaining half were translocated to OS directly from captivity (control cohort, 90% survival).

Post-release Monitoring

We fitted all translocated individuals with a metal band from the Australian Bird and Bat Banding Scheme and either an engraved leg flag or a set of colour bands for visual identification. We tracked individuals in 2014 - 2016 with tail-mounted VHF trackers for ≤3 months (until battery failure or tail-feather moult). We did not track birds in 2018. In 2019 - 2023, we tracked the birds with backpack-mounted solar-powered GPS transmitters for ≤4 years (until planned weak-link failure). We conducted post-release health checks in the first 6 months post-release in 2019 - 2023.

Major Difficulties Faced

Biological

Behaviour: Founders were initially naïve and vulnerable to predators, possibly as an unintended consequence of captive-breeding.

Predation: Eastern quolls (*Dasyurus viverrinus*), an endangered meso-predator reintroduced at MFWS in 2016 (Wilson et al., 2020), were responsible for some founder mortalities and one nest predation event.

Operational

Retrieval of tracking equipment: GPS units need to be <5% of a bird's body weight; however, their small size means they are easily lost in the field once they come off the bird. The PhD candidate for this project, Shoshana Rapley, trained a detection dog to locate the units and successfully retrieved all but one of the lost units.

Post-release capture: Since bush stone-curlews are cryptic and wary, it was initially difficult to catch them post-release. We developed catching methods, which enabled us to a) conduct post-release health checks, b) rapidly respond to fox predation at GNR in 2021, and c) experimentally translocate birds between MTR and OS in 2023.

Broad Underlying Problems

- *Invasive alien species:* Predation by foxes was a major source of mortality, especially before implementation of wing-clipping (see '*Major Lessons Learned*').
- *Climate change:* The following were the challenges, a) drought in 2019 necessitated water supplementation at MFWS, b) smoke from the 2019/20 eastern Australia megafires created hazardous air quality conditions in the ACT for 40 days, which reduced staff ability to conduct field work and possibly impacted the birds' health, and c) the translocation to OS was delayed due to widespread flooding in central Victoria in 2022.

Major Lessons Learned

- *Even very low fox densities are not tolerated during establishment; however, established birds demonstrate potential for coexistence:* Fox predation was a major source of mortality during establishment. The GNR release demonstrated that even a single cryptic fox can have detrimental impacts in the initial establishment period. However, tracking data revealed established bush stone-curlews (after regrowing flight



Young bush-stone curlew
© Belinda Wilson

feathers) spent half of their nights outside MFWS, and some had day roosts outside the fence (Rapley, 2020). This area had a high number of foxes and some domestic cats (despite local cat containment laws). We hypothesize that captive-bred birds are initially naïve and vulnerable, but can learn coexistence skills.

- *Wing-clipping is an effective tactic for this ground-adapted species:* Wing-clipping improved survival from 27% in 2014 to 80% in 2015. The tactic was used in all future translocations except in 2022 at MFWS. Wing-clipping is a temporary (lasting <1 year) morphological modification that reduces hyper-dispersal during the crucial establishment phase.

- *GPS-fitting innovation:* Switching from VHF to GPS enabled high resolution data collection for long durations (Rapley, 2020). GPS revealed surprising variability in the movement patterns of individuals; some remained anchored to the site while others made large dispersal movements over hundreds of kilometres. This suggests potential for connectivity of a restored population if sanctuary network is established.

- *Drip-feed release tactic:* From 2022 onwards, we released birds in groups of 2 - 4 over several nights instead of one large flock in a single night. This eased risk management in the first few days post-release where risk and uncertainty was high. If an unforeseen event had occurred, fewer founders were exposed to risk, and it was easier to respond (e.g., recapture).

Success or Failure of Project

Mulligan Flat Woodland Sanctuary:
(*growth phase*)

Highly Successful	Successful	Partially Successful	Failure

Goorooyarroo Nature Reserve:
(*pilot translocation; but subsequent natural colonisation*)

Highly Successful	Successful	Partially Successful	Failure

Mt. Rothwell Reserve:
(*establishment phase*)

Highly Successful	Successful	Partially Successful	Failure

Orana Sanctuary:
(*establishment phase*)

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- We achieved our pre-determined metrics for survival at MFWS, MTR and OS. Natural immigration from MFWS to GNR resulted in population establishment at GNR.

- Chicks have successfully fledged at MFWS every year since 2015 and at GNR since 2022; there are now 3+

generations at these sites. Chicks hatched but did not fledge at MTR in 2023.

- Adaptive management of translocation tactics helped improve survival rates across releases.
- Public engagement has been very positive. Volunteers assist on annual surveys and members of the public report sightings. Bush stone-curlews are regularly seen on education tours at MFWS and by residents of the adjacent suburbs, where the birds commute to forage (Rapley, 2020).
- A diverse and dedicated team whose passion, expertise, and creativity made this project possible.

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Author Details

[1] Fenner School of Environment and Society, The Australian National University, Canberra ACT 2601 Australia, shoshana.rapley@anu.edu.au*

[2] Environment, Commonwealth Scientific and Industrial Research Organisation, Canberra ACT 2601 Australia.

[3] College of Science & Engineering, James Cook University, Douglas Qld. 4814 Australia.

[4] ACT Parks and Conservation Service, Canberra ACT 2600 Australia.

[5] Mt. Rothwell Biodiversity Interpretation Centre, Little River, Victoria 3211 Australia.



Reintroduction of the endangered saker falcon in Bulgaria

Andrew Dixon[1]*, Yana Andonova[2], Andreana Dicheva[3], Rusko Petrov[4], Yordanka Vasileva[5] & Ivaylo Klisurov[6]

Introduction

The saker falcon (*Falco cherrug*) is designated as globally Endangered (EN) on the IUCN Red List of Threatened Species, listed in ANNEX 1 of the European Union's Bird Directive and categorised as Critically Endangered in the Red Data Book of Bulgaria. The species is listed on CITES Appendix II and, except for the Mongolian population, on CMS Appendix I. Saker falcons were extirpated as a breeding species in Bulgaria in the late 20th century, with the last documented breeding attempt recorded in 1998 (Ragyov et al., 2009). In 2006, the Environment Agency-Abu Dhabi initiated a conservation programme that included an assessment of the breeding status of the saker falcon in Bulgaria as part of a feasibility study for the potential reintroduction of the species in the country.

Main Goals

1. Establish a self-sustaining breeding population of saker falcons in Bulgaria.
2. To develop capacity, skills and techniques required for the reintroduction of threatened species in Bulgaria and elsewhere.
3. To use the reintroduction to promote wider conservation awareness, to protect other associated wildlife and habitats.

Success Indicators

1. Establishment of wild breeding pairs from released birds, in line with feasibility study modelling indicating population growth i.e., 2 - 4 wild breeding pairs after releasing 80 birds over 4 years.
2. Establishment of breeding facilities, captive-breeding group, equipment and

avicultural skills to facilitate future reinforcement.

Project Summary

Feasibility

Initially, we identified potential release areas based on previous occupancy, prey availability and size. However, recent historical distribution was mainly in upland regions, while elsewhere in Europe, saker population expansion in the 21st century has been associated with a switch to lowland agricultural landscapes. Thus, past distribution may not necessarily be a good indicator of future distribution. The saker falcon has been the subject of intensive conservation effort in the Pannonian Basin in recent decades, so this European population could not be used as a source for translocation, consequently we elected to use captive-bred birds as a source for release. Our modelling indicated that the release of 20 birds per year over a 5 year period would result in a viable, growing population (Ragyov et al., 2009; Lazarova et al., 2021).



Supplementary feeding of released falcons
© Yana Andonova - Green Balkans

Implementation

Following completion of the feasibility study, we established a captive breeding group of saker falcons, with a pedigree of European origin, at the Green Balkans Wildlife Rehabilitation and Breeding Center in Stara Zagora. Simultaneously, over a 3 year period, we conducted a series of pilot releases of captive-bred saker falcons to refine our release procedure and to use satellite-telemetry to assess the movements, survival and natal philopatry of the released falcons (N = 10 tagged birds; Dixon et al., 2019). Having determined that released saker falcons dispersed widely, we selected a release area that had a high local prey availability and was conveniently situated close to our breeding facility. During 2020 - 2024, limited productivity of the captive breeding group resulted in fewer releases than planned i.e., 84 rather than 100 individuals, but at the end of this period there were three pairs of wild-breeding saker falcons in Bulgaria, all originating from released birds.

Post-release Monitoring

The deployment of harness-mounted transmitters has been shown to have deleterious effects on saker falcons, so we opted not to track most of the individuals that were released for breeding recruitment. Instead, we erected artificial nests in the vicinity of the release site in the hope that they would attract breeding recruits. However, none were occupied by saker falcons during our programme, but general survey work located breeding pairs at three territories and GSM tracking of a released female revealed occupancy at a fourth territory. Furthermore, CCTV cameras at feeding areas around the release site identified several returning individuals that were released in previous years.



Landscape in the release area
© Yana Andonova - Green Balkans

Major Difficulties Faced

Biological

- Acquiring captive-breeding stock with European-origin provenance.

Operational

- Funding hiatus that disrupted staffing and breeding programme.
- Sourcing a reliable supply of appropriate food for the captive breeding group.
- Outbreak of avian pox among the captive breeding group.

Social

- Initial issue with getting wider acceptance of the project from other conservation organizations in Bulgaria.
- The effects of the Covid-19 pandemic.
- Escalating costs as a result of the conflict within the region (war in the Ukraine).

Broad Underlying Problems

- Decline and range contraction of an important prey species (European ground squirrel) for breeding saker falcons across much of the Bulgarian landscape.

Major Lessons Learned

- Artificial incubation could be used to 'double-clutch' and increase productivity of captive-breeding females
- Supplementary feeding for at least 1 month after fledging facilitated retention in the release area and increased likelihood of post-dispersal survival.
- The use of CCTV in breeding aviaries, the release (hacking) cage and at supplementary feeding tables enabled us to closely monitor all stages of the breeding and release process.

Success or Failure of Project

Highly Successful	Successful*	Partially Successful	Failure

** The main goal of establishing 2 - 4 wild breeding pairs after 4 years of releases was achieved with three known breeding pairs in Bulgaria in 2024. Furthermore, the project has resulted in facilities, equipment and trained staff for raptor reintroduction.*

Reasons for Success/Failure

- Dedicated and skilled staff to ensure the project was implemented successfully.
- We applied scientific research to support

our decision-making.

- There was community engagement from locals in the release area.

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Author Details

[1*] *Mohamed Bin Zayed Raptor Conservation Fund, Abu Dhabi, United Arab Emirates, adixon@mbzraptorfund.org*

[2] *Yana Andonova, yandonova@greenbalkans.org*

[3] Andreana Dicheva, adicheva@greenbalkans.org

[4] Rusko Petrov, rpetrov@greenbalkans.org

[5] Yordanka Vasileva, yvasileva@greenbalkans.org

[6] Ivaylo Klisurov, iklisurov@greenbalkans.org





Population reinforcement of black-tailed godwit in the UK: trialling 'headstarting'

William H. Costa [1]*, Rebecca Lee[2], Nigel S. Jarrett[1] & Lynda Donaldson[1]

Introduction

The black-tailed godwit (*Limosa limosa*), hereon refered to as godwit, is a large migratory shorebird with a breeding range from Iceland to far east Russia and wintering sites in Europe, Africa, Asia and Australasia. The *L. l. limosa* subspecies has undergone severe declines in breeding populations in western Europe (Jensen et al. 2008).

In the UK, *L. l. limosa* is Red-listed (Stanbury et al., 2021) with four small breeding populations. The population breeding at the Ouse Washes in England declined from 65 pairs in 1972 to just 3 pairs in 2000 due to increased frequency of spring flooding (Ratcliffe et al., 2005). Flood-free wet grassland was created as compensatory breeding habitat, but population modelling showed that even with good breeding success, the population was unlikely to recover significantly for several decades due to its critically small size.

Main Goals

1. Develop an effective translocation method for godwits, where effectiveness is judged on post-release survival, movements, recruitment and breeding success.
2. Increase the size of the Ouse Washes population by 15 pairs (500%) in 5 years.
3. Identify any limiting factors at the newly created wet grassland breeding sites.
4. Contribute to the wider UK conservation programme for godwits, including encouraging public support for wetland conservation and increasing understanding of the movements and migration of godwits breeding in the UK.

Success Indicators

1. Artificial incubation and rearing has a success rate of at least 80%, i.e. 80% of eggs collected result in fledged birds.

2. The demographic rates of released birds, raised artificially, are similar to those of wild-reared birds.

3. Released birds migrate on schedule with wild-reared birds to wintering sites in southern Europe and western Africa.

4. Recruitment of released birds to the Ouse Washes from 2019 onwards.

5. The number of breeding pairs at the Ouse Washes increases to 18 pairs by 2021.



Godwit release aviary

Project Summary

Feasibility

Feasibility work completed before translocation included justification and feasibility assessments, a captive trial and a disease risk analysis. Population modelling determined that a translocation could significantly impact the recovery of the target population and impacts on source populations would be negligible. Translocation techniques were based on methods developed for spoon-billed sandpiper (*Calidris pygmaea*). The captive trial allowed incubation and rearing methods to be tested for the target species. Suitable breeding habitat was available, and no significant problems were known at non-breeding sites. A risk assessment identified risks in relation to egg availability and the behaviour and survival of released birds, for which mitigation strategies were developed.

Implementation

Annually, 8 - 13 clutches of eggs, average of 4 eggs in a clutch, were collected from the Nene Washes, under licence from a national authority. Eggs were transported to purpose-built facilities near the Ouse Washes. After hatching, chicks were reared indoors for 4 - 7 days before being moved to outside rearing aviaries. After health assessments including disease screening, at 18 - 24 days old, birds were moved to a release aviary. Birds were released in similar aged cohorts shortly after fledging, at between 27 - 33 days old. Of 248 eggs collected, 216 (87%) hatched successfully and 206 (83%) were released: 144 at the Ouse Washes, and 62 at the Nene Washes.

Post-release Monitoring

Birds were individually marked with colour-rings and a single metal ring. Some birds were fitted with geolocators. Released birds were monitored for 5 - 8 weeks until they migrated. Colour-ring sightings and geolocator data allowed us to determine where birds were staging and wintering, and on return to project sites, birds were closely monitored throughout the breeding season. Released birds have been recorded in 10 flyway countries. They appear to be

migrating appropriately and are surviving and returning to breed at rates that would be expected for wild-reared birds. The population at the Ouse Washes increased to 19 pairs by 2021, surpassing the target and should increase further as more birds reach breeding age.

Major Difficulties Faced

Biological

Ecological: Unseasonable weather and high levels of nest predation made it difficult to locate enough eggs to establish optimally sized release cohorts in some years.

Climate: Flood events affected the quality of eggs in 2 - 5 years, e.g. submerging eggs in water or causing birds to nest in agricultural fields were eggs became coated in mud.

Genetic: Occasional leg deformities occurred during rearing, including leg splays and bent tibia metatarsus bones. These were managed with strict feeding and exercise routines to control daily weight gains. No birds were released with leg problems. Genetic factors were not identified as the leading course of leg deformities.

Operational

Moderate levels of staff turnover due to seasonal, short-term contracts and organisational changes.

Broad Underlying Problems

- *Suboptimal habitat:* Dry/drought conditions in some years delayed grass growth and reduced the availability of suitable nesting and chick-feeding areas.
- *Climate change:* Increased frequency of spring flooding reduced the availability of suitable nesting areas. New habitat has been created but its extent is much smaller than the extent of the original breeding site. For full population recovery, additional habitat must be restored or created.
- *Other:* Monitoring has identified high levels of nest and chick predation on some parts of the Ouse Washes. This will limit the growth of the reinforced population if it is not reduced.

Release site - Welney landscape





Radio-tracking released godwit

Major Lessons Learned

- Headstarting can be an effective method for boosting the size of a small breeding population of godwit. Headstarting is particularly suitable for this species because captive techniques can significantly increase the number of chicks that survive to fledge and the species shows high levels of philopatry.
- Artificial incubation and rearing success rates averaged 83% (including compromised eggs during flooding events), reducing the total number of eggs required to achieve release targets.
- Young godwits require intensive exercise and diet management to avoid developmental leg problems. Moving chicks to an outdoor environment with large areas for exercise should ideally be from around 4 days of age.
- When applying for licenses, seek flexibility on the timing of egg collection in case of unseasonable weather/late or early breeding seasons.
- Captive-reared godwit integrate into populations of wild-reared conspecifics and are not known to show maladaptive behavior.
- When designing artificial incubation and hatching facilities, include at least two spaces that separate egg incubation from chick rearing. This reduces the exposure of chicks to human activity.
- When planning staffing, wherever possible, try to avoid short-term contracts and employ staff for the duration of the project. Four experienced aviculturist staff are required as well as an experienced veterinarian.
- During intensive aviculture periods, use a rota system with overlapping shifts.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure
■			

Reasons for Success/Failure

- Captive incubation and rearing had an egg to release success rate of 83%, with a 90% success rate for eggs collected in



Juvenile black-tailed godwit
© Jonathan Bull, WWT

normal conditions e.g. not compromised by flooding, which exceeded the target of 80%.

- Preliminary data suggest the demographic rates of released godwits are similar to those of wild-reared birds. Colour-ring sightings and geolocator data have shown that released birds are migrating appropriately to southern Europe and western Africa.
- Released birds first recruited into the target population in 2018 and have returned to both release sites to breed. In 2022, ~40% of breeding pairs in the Ouse and Nene Washes contained one or two released birds.
- The number of breeding pairs at the Ouse Washes and adjacent sites increased to 19 pairs in 2021 and continued to increase up to 27 pairs in 2024.
- The headstarting trial was an important part of the wider conservation programme for godwits in the UK and was a useful tool to encourage public support by providing a tangible link to the plight of this bird and it's fenland habitat.

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Author Details

[1] WWT (The Wildfowl & Wetlands Trust), Slimbridge, Gloucestershire, GL27BT, UK, william.costa@wwt.org.uk*
(for EU LIFE Project: LIFE Blackwit UK LIFE15 NAT/UK/000753).

[2] The Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire SG19 2DL, UK.





Reintroduction of the golden parakeet in a protected area of the Brazilian Amazon

Marcelo Rodrigues Vilarta*, Crisomar Lobato, Mônica Nazaré R. F. da Costa, Rubens Aquino de Oliveira & Luís Fábio Silveira

Introduction

The golden conure (*Guaruba guarouba*) is an endemic psittacine found exclusively in the Brazilian Amazon Forest, making it a strong candidate for a national symbol due to the vibrant green and yellow colours of its plumage (Sick, 1997). Its striking appearance has made it a target for the illegal pet trade over the last century, which, along with severe habitat loss, has led to a significant population decline and local extinctions. Recent assessments estimate the population at around 10,000 individuals, with a projected loss of more than 30% within the next two decades (BirdLife International, 2022; Laranjeiras, 2011). The species is classified as Vulnerable (VU) on both the IUCN Red List and the Brazilian List of Threatened Species, and it also appears in Appendix I of CITES. Most of the wild population is located in the eastern Amazon, predominantly in Pará. The capital, Belém, is one of the areas where the species was extirpated over 100 years ago (Moura et al., 2014), and it is currently the site of ongoing reintroduction efforts. Given the need to address the primary factors contributing to the species' extinction, we have selected a protected area in this region for reintroduction (Vilarta et al., 2021).

Main Goals

1. Carry out captive breeding of golden conures to increase the stock population.
2. Reintroduce and monitor the golden conures in a protected area.
3. Establish a self-sustaining population of golden conures in a protected area.
4. Promote awareness of the local population through environmental education and publicity using the species as a flag/symbol.

5. Produce a protocol for captive breeding and reintroduction of golden conure based on the data recorded in this project.



Community presentation on the project

Success Indicators

1. Healthy and physically capable individuals are bred in captivity and sent to the release site.
2. Released individuals settle in the vicinity of the release site.
3. Released individuals can find and process natural food.
4. Released individuals reproduce on nest boxes.
5. Local population participating directly or indirectly in the monitoring and recording of the reintroduced birds.

Project Summary

Feasibility

The Lymington Foundation is a non-profit organization based in Juquitiba, SP, that specialises in breeding endangered birds and is supported by BluestOne. Having bred dozens of golden conures over the years, the Foundation has established a partnership with the Institute of Forest Development and Biodiversity of the State of Pará (IDEFLOR-Bio) to reintroduce these birds to their natural habitat. Through this collaboration, we have secured funding from an environmental compensation fund to implement this project.

The selected area is Utinga State Park, a protected area under the responsibility of IDEFLOR-Bio. The park encompasses over 1,400 ha of predominantly lowland rainforest. It is linked to the continuous forest to the south and east, as well as the urban environment to the north and west. In 2017, we constructed the acclimatisation aviary at the release site, which is situated on a partially cleared section surrounded by secondary vegetation in the centre of the park. The aviary consists of two parts: a suspended maintenance module connected to a larger cubic module featuring native vegetation inside and ample space for flight.

Implementation

Most of the birds selected for reintroduction were bred at the Lymington Foundation (95%), while the remaining birds came from wildlife centres, zoos, donations, and other sources. Before being sent to the release site, each bird underwent a series of tests for the most common infectious diseases (e.g., herpesvirus, bornavirus, circovirus) in accordance with Brazilian regulations for the translocation of birds. They were also evaluated for physical condition and flight capability. The conures that passed the sanitary, behavioural, and physical

examinations were transported by airplane to Belém, where they underwent a period of at least 5 months of acclimatisation and training in the aviary. During this time, they received native food daily and were familiarised with local fauna and potential predators.

We reintroduced the birds using a more gradual, soft-release approach, liberating them individually or in pairs and then attracting them back to the enclosure to repeat the process. Once most of the birds had gained experience, the group was released together. Nest boxes were placed over the enclosure and in nearby trees, while supplementary food and water were offered daily in suspended feeders.

From 2017 to 2025, we transported a total of 94 birds to the site and released 57 of them in seven groups. Fourteen birds are currently undergoing acclimatisation, while 23 could not be released. Most individuals that could not be released did not meet the necessary physical and behavioural requirements and had to be returned to the breeding centre, while some died before release due to predation, territorial disputes, and diseases.

The project experienced partial halts in 2019 and 2020 due to bureaucratic setbacks that delayed funding transfers. These challenges, combined with the pandemic shutdowns, resulted in only one release during this time. Fortunately, the IDEFLOR-Bio staff attended to the caged birds and conducted aviary maintenance (with one release), adhering to the protocols established by the Lymington Foundation.

Post-release Monitoring

The birds are monitored daily by tracking and recording their activities as they leave their nests. We search the main roads and trails around the park, utilising playback emissions and VHF radio tracking.Survival could not be accurately assessed because most birds had dispersed and were not resighted. Nevertheless, it was possible to confirm that 40% of the released conures survived their first year, although we also established that 12% experienced mortality during that time. The fate of the remaining 48% remains unknown, as some of the birds quickly dispersed from the monitored area.

Two individuals who dispersed after their release were found the next day at a distance of 7 km, indicating that the species can travel long distances in a very short time.

Three successful reproductive events were documented in the nest boxes over the enclosure: one in 2018 and two in 2024. The first and third events each resulted in one chick raised to adulthood, while the second event produced five chicks at once.

Fifteen birds currently inhabit the area near the release site, while four others are occasionally seen in a nearby town located 6 km away.

The results, though incomplete, demonstrate that reintroduced golden conures can adapt to wildlife in their historic environment. However, the long-term outcomes have yet to be determined and will depend on ongoing supplementation and close monitoring of the population in the coming years.

Major Difficulties Faced

- The main issue was the elevated dispersal of birds upon release. Many flew past the range where the monitoring was feasible.
- Telemetric monitoring with VHF collar transmitters was insufficient to track the individuals through long distances since the radio signal was significantly weakened in both dense vegetation and urban environments.
- Territorial aggression was problematic before and after release. Fights inside the aviary led to losses of individuals, while constant persecution outside led to the dispersion of birds shortly after their release.
- Predation was a major problem in the pre-release period when constrictor



Nest box with juveniles

snakes could find ways to access the enclosure at nighttime.

- The reproductive rate of released conures was slower than expected, reducing the addition of new individuals to the population.
- The interruption of funding ceased new releases and continuous monitoring from 2019 to 2020, which led to the loss of data and reduced the addition of individuals to the population. However, during the pandemic, the team of GBio/ IDFLOR-Bio kept visual monitoring of the birds and received reports about birds found in different areas of Belém, which also shows the engagement of citizen scientists in the project.

Broad Underlying Problems

- Human-related disturbances in the release site increased significantly once due to the opening of the protected area to visitors.
- Powerlines and man-made structures representing threats are present in the protected area and cause fatal accidents.
- Funding depends on short-period contracts of 2 - 3 years, which may hamper the continuity of activities and the long-term implementation of the project.

Major Lessons Learned

- The intensity of intraspecific aggression was higher during the breeding season. However, by increasing the enclosure size and reducing the captive groups to 10 individuals, the aggressions were reduced.
- Predation was significantly reduced once the enclosures were covered with a thinner metallic net, and the nest boxes were placed on isolated trees with a metallic belt installed on their base.
- Bringing the established conures back inside the enclosure to interact with the release candidates may improve the bonding and flocking between groups.
- Locating released conures immediately after their first flight is essential for not losing track of them. It is also exceptionally challenging since they stay mostly silent and do not respond to playback in the first hours. Therefore, using efficient telemetry techniques is vital to obtain data on their post-release movement.
- Community involvement is valuable in finding birds that disperse to the urban area.

Success or Failure of Project

Highly Successful	Successful*	Partially Successful	Failure

** The project is still ongoing, but most of the main goals have been achieved.*

Reasons for Success/Failure

- Most birds arrived at the release site in an ideal physical status since they were bred in optimal conditions.
- Although the presence of experienced and established birds in the release site was an issue for some new individuals who suffered aggression, it was also favorable for the accepted individuals. In those cases, the older ones acted as guides during the first flights, returning lost individuals to the release site.

- The frequent presentation of natural food during pre-release training was effective enough that some individuals were observed searching for the same foods in the wild immediately after the release.
- Placing protected nest boxes in the vicinity provided a safe and familiar place for the birds to spend the night and enabled reproduction.
- The project's exposure through media publicity and environmental education actions made the local population aware of the conures, which resulted in people reporting their movements in the urban area and helping in rescues.
- A preliminary protocol was produced in the second year of the project. By basing the following methods on this guide, we have obtained better pre- and post-release results.

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Author Details

* *Marcelo Rodrigues Vilarta – Field Biologist at Lymington Foundation. PhD student at Seção de Aves, Museu de Zoologia da Universidade de São Paulo (MZUSP), Rodovia BR316, 1760. Ananindeua, PA, Brazil, marcelovilarta@hotmail.com*

Crisomar Lobato, dgbiodiversidade@gmail.com

Mônica Nazaré R. F. da Costa, gbio.ideflorbio@gmail.com

Rubens Aquino de Oliveira, gbio.ideflorbio@gmail.com

Luís Fábio Silveira, lfs@usp.br





Release of the Visayan tarictic hornbill in the Bayawan Nature Reserve of Negros Island, Philippines

Edward Pelter*, Matt Ward, Monica Atienza

Introduction

The Visayan tarictic hornbill (*Penelopides panini*) is listed as Endangered in the IUCN Red List, under criteria A2cd+4cd, C2a(i), and was last assessed in 2020 (IUCN, 2023). It is regionally endemic to the West Visayan faunal region, on the islands of Negros, Panay, Masbate and Guimaras (Sammler et al., 2012). Visayan hornbills are a relatively small hornbill, growing to around 45 cm in height and weighing between 400 - 500g (Ward, McPherson & Magbanua, 2021). This species has sexual dimorphism, with the males having a white head and chest with black wings and black tail tips, whereas the females have black bodies with white chins and blue around the eyes.

The Bayawan Nature Reserve (BNR) is a 300 ha tropical secondary growth forest situated on Negros island in the Philippines. This area had been denuded, used for agroforestry and for coconut production previously, before natural and supplemented forest restoration created the secondary forest we use today. The trees are between 30 - 50 years old at most. Communities around the reserve highlighted that this area was a former hotspot for *P. panini* with regular sightings but also rampant poaching for sport and pets. Surveys conducted prior to the release showed that despite healthy forests and abundant food there were no confirmed live birds remaining.

Main Goals

1. To establish a new population for species protection and to increased potential for fragmented meta-populations to mix across the island of Negros.
2. To have successful reproduction of translocated animals in the wild.
3. To support breeding by creating nest cavities or supplying artificial nest boxes,

which are later used by breeding pairs.

4. To restore the extirpated Bayawan hornbill population to help with local biodiversity services and habitat restoration.

Success Indicators

1. At least 50% of released hornbills will stay within the reserve and surrounding area for the first year.

2. At least 30% of released hornbills will survive the first year.

3. Individual birds will pair-bond naturally post-release, and reproduce to increase the wild population.

4. Released hornbills will disperse outside the reserve to breed/connect with the wild hornbills within the first 5 - 7 years.

5. At least 20 nest boxes suitable for Visayan hornbills have been set up in the reserve.

Project Summary

Feasibility

The Bayawan Nature Reserve has abundant fruiting trees and animal prey for the hornbills to feed on and rear offspring. The reserve is bordered by four small communities and 3,000 ha of degraded natural landscapes to its West. It is rich in biodiversity with numerous endemic and Endangered species including potential predators such as the Visayan leopard cat (*Prionailurus bengalensis rabori*), multiple raptors and snakes. The city government is supporting the release by providing the Talarak Foundation authority over the site's management in addition to funding. The primary threats are hunting from community personnel, and a lack of natural nests.

Implementation

Twelve sub-adult hornbills were selected for release and moved into two intersexed soft-release aviaries at the nature reserve in late 2020. In February 2021, a disease infected many of the hornbills and unfortunately five were lost to the unknown disease. From the remaining individuals 4 birds (3 male, 1 female) were selected as suitable for release into the reserve based on behaviour and body condition. In August 2021, these birds were released with the aviary opened to allow them to acclimate naturally to the environment with supplemental food, water and shelter.



Tarictic hornbill released into the wild

Post-release Monitoring

The released individuals were equipped with solar powered GPS tags using either VHF or cellular data download. Unfortunately, the hornbills spend most of their time under canopy, only basking for brief periods, preventing full use of the tags. Within the first 30 days the female individual had chosen and started to bond with 1 male, leaving the other 2 males to leave the reserve. Despite telemetry issues, all birds were ringed and beak pattern photos taken so identification could be possible. From bonding in August 2021 the new pair successfully fledged a chick in June 2022, but the male was predated in November that year. The female however successfully bred

with a wild male in 2023 producing two more chicks.

Major Difficulties Faced

Biological

- Prior to the release, the selected birds were hit with an unknown disease in the soft-release aviaries. It is still unsure what the disease was as all tests came back negative for suspected bacterial or viral infections, and necropsies did not show any major signs of trauma or internal defects.

- After the release of 3 males with 1 female, the female chose a preferred male to bond with and the remaining 2 males decided to leave the reserve. This was a known risk, we were hoping the birds would remain in the area waiting for new females to arrive, however they chose to leave in search of new females.

- Given the degraded and young age of the forest tree species there are no suitable natural nests for the hornbills within the reserve or surrounding area. To combat this we have built and installed 20 nest boxes of various designs (known to work in captivity) to encourage and support the nesting of released hornbills or wild hornbills inside the reserve.

- Along with native biodiversity that supports the hornbills and their forest environment (such as warty pigs, spotted deer, civets etc.) there are native predators of the hornbill present. We have documented numerous birds of prey (including goshawks, hawk eagles and serpent eagles which are capable of predating on *P. panini*) as well as leopard cats, Malay civets, monitor lizards (known hornbill nest predators) and invasive domestic cats. One predator, suspected to be either a northern goshawk or Malay civet, has already impacted the release by predating on the pair-bonded translocated male. Fortunately he had already successfully fledged a new male heir and his former mate has now re-bonded with a new wild originated male.

Operational

- The monitoring method of using GPS tags for telemetry movement recording was unsuccessful as the devices required solar power to maintain activity. Alternative methods would have used battery powered data loggers which either require recapture to collect data, or only last 90 days of recording, given the restraints with device weight.

- Camera traps were placed in fruiting trees, the soft-release aviary, supplemental feeding stations and nest boxes. These cameras recorded some very interesting and important information regarding bonding processes, nesting behaviour and diet, and frequency of feeding station visits. However with abundant food available in the forest there was limited observation at feeding stations, and we could not supply nest cameras to all nests so camera establishment had to occur after female sealing in the nest.

Social

- Despite continuous monitoring and engagement from the reserve outreach team, there are still accounts of bird poaching from certain villages outside the reserve. Many of these accounts relate to poaching for food, pets or for sport, and there is an understanding of the importance of the hornbills for the area. However we are concerned a prolonged hunting tradition will impact our hornbill establishment long term.

Broad Underlying Problems

- In spite of recent reforestation and restoration efforts, the reserve and its surrounding habitats are suboptimal as there are no trees currently suitable for the birds to create their nests and rear their young (Datta & Rawat, 2004). To combat this Talarak have built nests boxes across the reserve that can *P. panini* (along with other native cavity nesting species such as blue-naped parrots) and help them successfully breed and produce chicks, as evident 2 years in a row with two different nest box designs (Ward, McPherson & Magbanua, 2021).

- Human wildlife conflict is a big issue

regarding Visayan hornbills as they are hunted for food and pet trade or even sport. It is believed that in the last 20 years the Visayan hornbill population has dropped from around 2,000 individuals to less than 1,000 across its range of Negros and Panay (Mynott et al., 2021). The remaining populations exhibit loss of genetic diversity and they are genetically isolated due to at least 100 km distance between currently available habitats (Sammler et al., 2012).

Major Lessons Learned

- The current tracking equipment and observation methods are unreliable and more research needs to be done to produce more viable monitoring techniques for this hornbill species.
- In the first breeding event of our hornbills there was no exterior door placed on the nest meaning the researchers could not gain access which stopped them from placing any tags or tracking equipment to the offspring. With the second nesting event we had placed an exterior door which meant we could check the chick's health and place a tag on one of the individuals.
- When monitoring the nest boxes, we found that our cameras could be affected by weather or by the hornbills themselves which reduced the amount of data we collected. We found that using a secondary camera could mitigate most of these issues, so in the future we will use multiple cameras to view the nesting sites.
- Released hornbills are very territorial so the expected density per sq./km may differ from wild populations and needs further study.
- Hornbill chicks and their mother will follow their father to his territory once they have fledged within the mothers range.
- The food resources found in a secondary growth forest are adequate to support the survival of adults and new chicks through fledging. This is very important as so much of the primary forest in the region has been destroyed. Currently there is less than 10% primary forest left in their range, but there is still hope that the Visayan hornbills can breed and rear chicks in these less optimal habitats.



Tarictic hornbill in the wild

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- The Visayan hornbill release project was is a success as the released hornbills continue to breed with viable offspring in the reserve 3 years consecutively. Their first offspring (male) is thriving in the reserve after 2 years and has already been observed bonding with a female who was released to accompany him. A second breeding event created two fledged individuals (1 male, 1 female), with a third event producing one new female individual, all of who fledged and left the nest successfully with the

parents.

- The breeding events took place in the artificial nest boxes provided for them, with three different nest box styles successfully used.
- The two remaining hornbills (first born male and his female companion) are thriving in the reserve with no current problems with weather events, food availability or interspecific conflicts. The parents continuing to return each year to breed in the nest boxes, despite residing predominantly in another location. The continued return of these individuals is a relief as it highlights the availability of sustainable food and shelter outside the reserve, but also highlights the lack of natural nests in adjacent forests
- Concerns are still present around the safety of the hornbills in further reaching degraded forests and around communities where hunting is still present, although persistent education and engagement is highlighting an acceptance of the species and desire for it to flourish.
- We are yet to identify a suitable monitoring method for the species, especially to monitor newly born individuals without invasive procedures, in order to record dispersal and family dynamics across the years.

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Author Details

** Edward Pelter, Talarak Foundation Inc., Bayawan Nature Reserve, Bayawan City, Negros Oriental, Philippines, 6221,*
edwardpelter@gmail.com

Matt Ward,
talarakconservationteam@gmail.com

Monica Atienza DVM,
monicamarie.atienza@gmail.com



Reintroduction of the vinaceous-breasted Amazon in the Araucarias National Park, Brazil: 15 years of socio-economic and environmental impacts

Vanessa Tavares Kanaan* & Carolina Carvalho Cheida

Introduction

The vinaceous-breasted Amazon (*Amazona vinacea*) is one of the most threatened parrot species in the Brazilian Atlantic Forest, a biodiversity hotspot. It is listed on CITES Appendix I and classified worldwide as Endangered C2a(i) (BirdLife International, 2017) and Vulnerable in Brazil (MMA, 2022). *A. vinacea* was considered extinct in the area that is currently protected by the Araucarias National Park, southern Brazil. Aiming to reintroduce the species locally, several actions have been taken since 2010, following the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA), Chico Mendes Institute for Biodiversity Conservation (ICMBio), Santa Catarina Environmental Institute (IMA-SC) and IUCN guidelines. Actions include parrot rehabilitation, release and monitoring, as well as environmental education, generation of income for local people, among others. The project was first reported in Kanaan (2016). Here we detail 15 years of data, achievements and changes up to January 2025.

Main Goals

1. Rehabilitate *A. vinacea* parrots and select individuals for release according to their genetic, sanitary and behavioral status.
2. Acclimate, release and monitor parrots and their wildborn offspring at the Araucarias National Park.
3. Find licensed institutions that can care for parrots who do not meet genetic, sanitary and behavioral criteria for release.
4. Generate and provide scientifically sound information about *A. vinacea* well-being and conservation issues to stakeholders, including the local community, public, scientific community as well as decision makers and regulators.

5. Create socioeconomic opportunities for the local community, having *A. vinacea* as a theme.



Environmental education for schoolchildren
© Marcelo Sato

Success Indicators

1. Parrots rehabilitated and transferred to licensed institutions or to acclimation for release according to genetic, sanitary and behavioral criteria.
2. Released parrots survived and bred in the wild.
3. Scientifically sound information about *A. vinacea* generated and shared with stakeholders.
4. Behavioral changes in the local population in favor of *A. vinacea*, achieved through environmental education and income generation projects.
5. The Vinaceous-breasted Amazon Protection Network implemented.

Project Summary

Feasibility

The vinaceous-breasted Amazon is endemic to the Atlantic Forest, occurring in Brazil, Argentina and Paraguay. After a period of illegal wildlife poaching and trade, the species became locally extinct in Ponte Serrada and Passos Maia, Santa Catarina, Brazil. In 2005, the Araucarias National Park (ANP; 12,000 ha) was created in the region. Its Management Plan suggested the species reintroduction (Rupp, 2009), which was initiated in 2010, including educational and socioeconomic actions (Kanaan, 2016). The project implementation helped reduce threats that occurred, such as illegally kept wild animals, the presence of domestic animals and harvesting of pine nuts at the ANP.

Implementation

Since 2010, 563 parrots ex-trade/ex-pet, rescued and captive bred went through rehabilitation for up to 2 years. A total of 139 parrots did not meet sanitary, behavioural and genetic criteria and were transferred to licensed institutions. A total of 257 individuals met the criteria and were transferred to the ANP for acclimation and releases that happened in 12 events from January 2011 to June 2023. Environmental education actions has been conducted in schools, properties, business and events. Income generation opportunities have been created with the production of handcrafts and birdwatching ecotourism. Data have been collected, analysed and shared with stakeholders.

Post-release Monitoring

Over 100 communities have been visited in the ANP region to monitor released parrots and connect with local people. Researchers and citizen scientists have recorded groups of 2 - 15 parrots, including 12 wildborn offspring. Confirmed mortalities' (15.56%) main reason is predation by wild and domestic animals. Scientific communications (n=34) were made in events and publications. The Vinaceous-breasted Amazon Protection Network was maintained. Educational activities and

distribution of Activity Guides occurs annually in 12 schools. Birdwatching events (n=26) have been held since 2017, proving income for local guides. An income generation project for local artisan women resulted in 62% increase in income.

Major Difficulties Faced

Biological

Ecological: In the beginning of the project, parrots predation by domestic animals was the major difficulty. In recent years, it is the predation by native species such as small wildcats and hawks.

Climate: Occurrences of heavy rains and tornadoes have increased in the region, which may be affecting the availability of food, shelter and nesting cavities.

Anthropogenic: Logging at the ANP surroundings, as well as the implementation of small hydroelectric centres, are decreasing parrots habitat and may be affecting the availability of food, shelter and nesting cavities.

Behavioural: Some parrots approach rural properties around the ANP after their release, where they find shelter from many wild predators, but may receive food or come into contact/conflict with domestic animals.

Operational: Structural, financial and human resource limitations, since the work is carried out by an NGO with limited financial support.

Social: Excessive harvesting of Araucaria pine seeds (*Araucaria angustifolia*, EN in Brazil) for human consumption in times of scarcity of other food resources for parrots. The presence of domestic animals in the ANP and its surroundings.

Legislative: Extreme bureaucracy to acquire and renew licenses for long-term reintroduction project.

Broad Underlying Problems

- *Human-wildlife conflict:* Some parrots stay close to rural properties and people maintain a close relationship with them, but respect their freedom.
- *Interaction with domestic species:* In decreasing occurrence, there has been predation by domestic cats and dogs in the ANP and surroundings.

Major Lessons Learned

- It is possible to successfully rehabilitate and release parrots victims from illegal wildlife trade, improving animal well-being, contributing to species conservation and giving individuals a chance to play their ecological roles as an important seed disperser of the Araucaria tree (*A. angustifolia*).
- The maintenance of a constant supplementary food source around the acclimation enclosure made it possible for groups of parrots from different release events to meet and learn from each other.



Nest box installation © Instituto Fauna Brasil



Fledglings in nest box © Instituto Fauna Brasil

- The use of radio telemetry for parrot monitoring has low cost-benefit in the Brazilian Atlantic Forest region due to the high cost and limited data provided in dense forest regions for a short period considering parrots lifespan and dispersion.
- The use of numbered medals in collars has greatly increased parrots long distance identification.
- Involving the local community in parrots' monitoring through citizen science increased monitoring success, improved surveillance efforts, decreased poaching and the maintenance of illegal wild animals and increased the sense of belonging by locals.
- The creation of the Vinaceous-breasted Amazon Protection Network, with representatives from various government institutions, effectively improved communication between important local actors, resulting in increased surveillance and rescue efforts for wild animals in the ANP and surroundings with minimum costs.
- Creating economic value for free parrots by empowering the community to create and sell *A. vinacea* themed handcrafts and promote birdwatching and ecotourism seems to have decreased illegal poaching and trade in the region, as well as the maintenance of illegally kept wild animals.
- The species' low reproductive rates associated with the high predation makes the establishment of a long-term viable population harder without constant management.
- The difficulty to get authorization to manage wild predators in a Brazilian national park is a limitation to decreasing their threat to parrots, especially in the case of endangered predators species.
- Through a simple change of guidance to the local community regarding free-ranging individuals of *A. vinacea*, we encouraged the community to become partners and citizen scientists: instead of instructing them not to feed/interact (which they did despite orientation), we taught them to make feeders in safe places and the type of food to be offered.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- By having the first parrot reintroduction effort in a Brazilian national park approved by ICMBio, we were successful at rehabilitating, releasing and monitoring. The knowledge gained not only benefit the project, by adjusting and improving the methodology used each year, but is also shared with all environmental agencies involved in evaluating other proposals as well as with other release/reintroduction projects.
- The installation of nest boxes created new nesting opportunities for parrots and improved monitoring once the location was known and more accessible to researchers. Many natural cavities used by parrots were located in privately owned properties that required authorization for access, which did not always allow for effective monitoring effort.
- We were successful finding institutions

that received all parrots who did not meet criteria for release by creating a network of zoos and other types of establishments that have authorization to keep *A. vinacea* in Brazil. The list of available parrots was sent monthly to the network and the transfer analysed and approved by the proper governmental agency at the time of the transport.

- By creating the Vinaceous-breasted Amazon Protection Network we were also successful in helping environmental agencies in many ways, such as by providing the proper route to confiscate parrots, which was a limitation that kept them from patrolling.

- There have been changes in the profile of major threats to parrots from illegal poaching to predation. The decrease in the intensity of threats was reached by the implementation of several educational activities and socioeconomic opportunities created to the local community, as well as the empowerment of environmental agencies through the Vinaceous-breasted Amazon Protection Network.

- In the beginning of the project, domestic animals were a big problem inside the ANP. This problem was minimized by bringing this issue to ICMBio and helping find solutions for rescued cats and dogs. In recent years, parrots have been predated especially by wild animals, some of which also threatened or almost threatened species, such as the Margay cat (*Leopardus wiedii*; VU in Brazil and NT worldwide) and ornate hawk-eagle (*Spizaetus ornatus*; LC in Brazil and NT worldwide). It is necessary to encourage wildlife and domestic animals management discussions and actions in Brazil in order to minimize the threat posed by predation.

- The engagement of community and governmental agencies is a major reason for the project success. Many local initiatives have happened to support *A. vinacea* conservation such as choice of species by the locals as symbol of the ANP, picture of the species in school buses and bus stops, the production of stamp with the species as a theme, calls for interviews and podcasts on local radio stations, among others.

- Great acceptance of the Educational Activities Guide among local schools and teachers increased the number of students reached considerably when compared to the time when only researchers gave lectures or classes to the students. It also provided teachers with information to create and implement their own activities, such as choosing *A. vinacea* as a theme for the Nacional Independence Day Parade in the municipality of Ponte Serrada.

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Author Details

[*] *Instituto Fauna Brasil, Servidão Cinco Rosas, 19, Rio Vermelho, Florianópolis, SC, Brazil, 88060-425, vanessa@institutofaunabrasil.org.br*



Conservation breeding and population reinforcement of the Florida Grasshopper Sparrow, Florida, USA

Karl E. Miller[1]*, Adrienne Fitzwilliam[1], Juan C. Oteyza[1], Andrew Schumann[2] & Craig Faulhaber[3]

Introduction

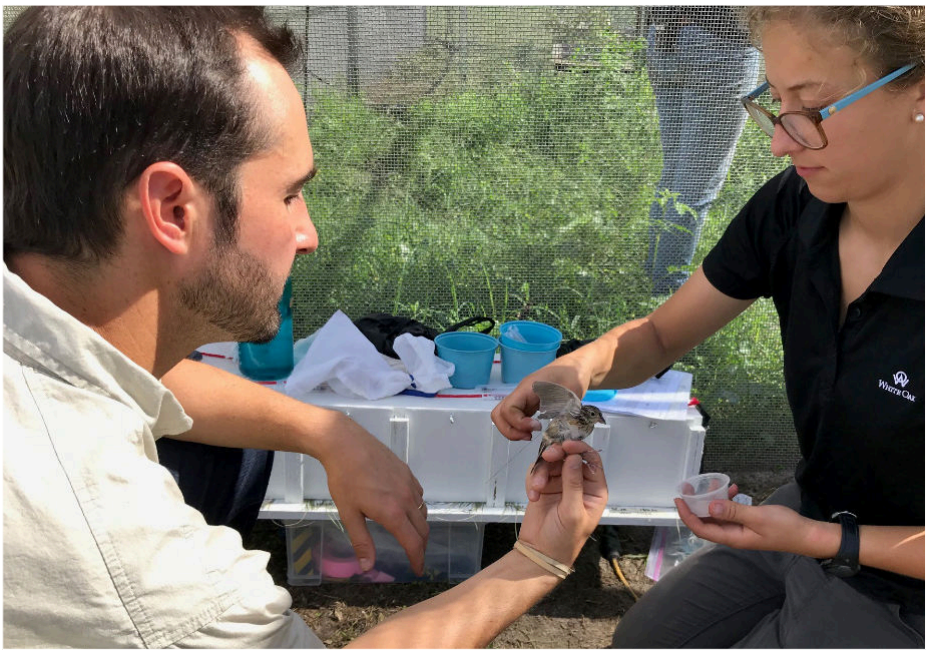
The grasshopper sparrow (*Ammodramus savannarum*) is a widely distributed species in North America, Central America, and the Caribbean, whose population decline does not currently qualify for listing as threatened on the IUCN Red List. However, the Florida grasshopper sparrow (*A. s. floridanus*) is a critically imperilled, non-migratory subspecies restricted to the dry prairies of southern Florida, USA, and is listed as Endangered under the U.S. Endangered Species Act. Despite ongoing management efforts, sharp declines in Florida grasshopper sparrow populations have been documented in recent decades, and the subspecies is nearing extinction.

During the 2018 breeding season, there were only 23 known breeding pairs remaining in the wild. Habitat loss and altered fire and hydrology patterns likely have contributed to population declines of this grassland bird. Recent research confirms that survival and productivity rates are too low to support a stable population (Hewett Ragheb et al., 2019b).

In 2015, the U.S. Fish and Wildlife Service (USFWS) initiated a captive-breeding programme to reinforce the dwindling wild population. In 2018, the Florida Fish and Wildlife Conservation Commission (FWC) and USFWS developed a 5-Year Strategic Vision that included ongoing habitat management, nest protection, and demographic research, as well as reinforcement with captive-reared birds (USFWS and FWC, 2019). The overall conservation goal of the Strategic Vision was to reduce the risk of extinction by stabilising and growing the wild population.

Main Goals

1. Restore and maintain occupied and potential habitat.
2. Conduct demographic monitoring and increase nest success in the wild.
3. Evaluate and manage disease risks associated with releasing captive-reared birds into wild populations.
4. Determine optimal age to release captive-reared birds to maximize recruitment.
5. Release enough captive-reared birds each year to stabilize and/or grow wild populations.
6. Work with stakeholders to share resources to implement Florida grasshopper sparrow recovery efforts.



Florida sparrow health check in captivity
© Karl Miller

Success Indicators

1. Optimal habitat conditions are maintained in priority areas on conservation lands through prescribed burning (Hewett Ragheb et al., 2019a), mechanical treatments, and cattle grazing (Hewett Ragheb et al., 2022).
2. Birds are colour-banded and monitored to estimate survival and population size, and nests are located and protected from predators and flooding (Hewett Ragheb et al., 2019b).
3. Captive-reared sparrows are released without introducing high-risk pathogens, and no disease outbreaks occur in wild populations.
4. At least one age-class released will have a female recruitment rate of ≥15%, and sparrows exhibit reproductive success comparable to wild birds.
5. The wild population at the main release site reaches a minimum target of 23 breeding pairs.
6. Resources of a variety of partners are leveraged to implement and expand the scope of the release programme.

Project Summary

Feasibility

The Florida Grasshopper Sparrow Working Group was established in 2001 to coordinate recovery efforts. Dozens of biologists and managers from state and federal agencies, universities, non-governmental organisations, and conservation groups meet regularly in break-out groups to focus on specific research or management questions. After a Structured Decision Making (SDM) process during 2014 - 2015, USFWS recommended a captive-breeding and release programme for Florida grasshopper sparrows. Biologists strategically collected wild birds and eggs from three wild populations to develop a flock of breeders at ex situ conservation breeding facilities. White Oak Conservation in Yulee, Florida, was selected as the primary breeding facility.



Florida sparrow release © Juan Oteyza

The largest remaining population of the Florida grasshopper sparrow is located at Three Lakes Wildlife Management Area (Three Lakes). FWC biologists have monitored the Three Lakes population since the 1990s and conducted demographic research with colour-banding since 2013 (Hewett Ragheb et al., 2019a, 2019b). Three Lakes was chosen as the first release site for Florida grasshopper sparrows because of its size and importance, its effective habitat management with prescribed fire, and its accessibility for installing a large release field aviary to house birds just prior to release.

Implementation

Our team used protocols for husbandry, care, transport, and release that were previously tested on a related subspecies, the eastern Florida grasshopper sparrow (*A. s. pratensis*), by White Oak Conservation and Tall Timbers Research Station. At White Oak Conservation, Florida grasshopper sparrows were kept in aviaries and paired up before the breeding season. Ongoing demographic study of colour-banded wild birds allowed us to create a multi-generational pedigree. We avoided inbreeding and maximised genetic diversity using PMx software (Species Conservation Toolkit Initiative; Ballou et al., 2025) to inform collection and pairing decisions throughout the project. After initial success, three additional facilities were incorporated for breeding or housing captive-reared sparrows (Avian Preservation and Education Conservancy, Jacksonville, Florida, USA; Welaka National Fish Hatchery, Welaka, Florida, USA and Brevard Zoo, Melbourne, Florida, USA). Our team maintains an annual average of ~16 breeding pairs in captivity across all facilities.

All efforts were made to mimic wild conditions at conservation breeding facilities by providing preferred nesting substrate and ground cover in outdoor sparrow enclosures. Adults built nests, laid and incubated eggs, and fed young without human assistance. We minimised stress on juveniles by handling them on no more than two or three occasions, including the day they received immunisations and were transferred to the release site. Details on husbandry and animal care can be found in Oteyza et al. (2025). We organised an IUCN-facilitated Disease Risk Analysis (DRA) workshop in November 2018 to bring experts together to assess and manage risks of pathogen transmission from captive to wild Florida grasshopper sparrows. Prior to any releases, disease assays revealed the presence of low levels of the same pathogens in both wild and captive settings.

The IUCN Conservation Translocation Specialist Group recommends releasing captive-reared birds at ages that maximise translocation success. However, we could find no data-driven guidelines for determining that optimum age. Therefore, we released Florida grasshopper sparrows as independent juveniles (i.e., hatch-years) during the summer and as young adults (i.e., second-years) after their first winter in captivity in an adaptive framework and monitored their subsequent reproductive performance. During 2019 - 2021, 32 of 181 (18%) sparrows released as hatch-years recruited (i.e., were confirmed to be paired and breeding), whereas only 4 of 84 (5%) sparrows released as second-years recruited (Oteyza et al., 2025). We also conducted a systematic literature review on this topic, which found additional support across a wide range of avian taxa for better survival and recruitment of birds when they are translocated at younger ages (Miller et al. 2024). Beginning in 2022, the release programme focused on releasing hatch-years, which boosted translocation success, while easing capacity constraints at White Oak Conservation.

This discovery, along with the inclusion of additional breeding facilities, allowed us to produce more Florida grasshopper sparrows for release each year. Using an adaptive framework, we learned that long acclimation periods (1 - 3 days) at an in situ aviary at Three Lakes provided no benefits to the sparrows. Beginning in 2021, many sparrows were held 0 - 1 days in a small (2 m x 4.5 m x 2 m) mobile aviary built on top of a utility trailer, which saved time and allowed us to distribute released birds more effectively across the landscape.

Post-release Monitoring

We continued ongoing demographic research at Three Lakes, including systematic replicated point count surveys to resight colour-banded birds, locate nesting territories, and find nests (Hewett Ragheb et al., 2019a). FWC biologists developed a novel technique for installing temporary



Female Florida sparrow on a wild nest
© Londa Nong

fences around Florida grasshopper sparrow nests to minimise predation rates (Hewett Ragheb et al., 2019b). By the 2020 and 2021 breeding seasons, 65% of the fledglings at Three Lakes came from nests that had at least one captive-reared parent. When the Three Lakes population reached its target goal of 23 breeding pairs in 2021, the programme was expanded to include an additional site (Avon Park Air Force Range, Avon Park, Florida). As of 2024, we have released a total of 1,200 Florida grasshopper sparrows on the landscape.

Major Difficulties Faced

Biological

Climate: New threats to nests, such as unprecedented flooding in 2016 and predation by red-imported fire ants (*Solenopsis invicta*), have been difficult to mitigate.

Operational

Large field crews are needed each year to monitor wild populations, track released birds, and protect all nests.

Conservation breeding requires leveraging budgets from multiple sources.

Early in the project, we had space constraints for housing hatch-year sparrows.

Some conservation lands continue to face budgetary and logistical challenges with restoring and maintaining sparrow habitat in optimal condition.

Native dry prairie, working lands, and military installations have different management constraints.

Broad Underlying Problems

- Environmental conditions in the wild that contributed to population declines are still not well understood. More research is needed to find additional management actions that would lead to sustainable population growth in the wild to eliminate the continued need for captive rearing and release.

Major Lessons Learned

- Using a closely related sparrow subspecies as a model reduced programme startup time.
- Translocating wild sparrows to managed care is a highly effective strategy when conservation breeding facilities mimic the natural environment (e.g., outdoor enclosures) and minimize handling.
- Released hatch-year birds have greater survival and recruitment in the wild than birds released after they spend their first winter in captivity.
- Long acclimation periods in cages at the release site were not necessary, which has facilitated the current use of mobile aviaries with faster release.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- Developing a 5-Year Strategic Vision, with partner input, established clear objectives, timelines, and criteria to evaluate our success.
- Collaboration and financial support from multiple agencies and partners (USFWS, FWC, Florida's Nongame Wildlife Trust Fund, Fish and Wildlife Foundation of Florida, University of Florida, Florida Park Service, U.S. Department of Defense, Archbold Biological Station, Florida Audubon, and conservation breeding facilities) was critical for successful implementation.
- Our project quickly identified the most effective age for releasing captive-reared sparrows, which also allowed us to save time and resources by not housing sparrows overwinter before releasing them.
- Despite our success in reducing the risk of extinction, wild populations may not yet be sustainable without continued reinforcement.

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Author Details

[1] Karl E. Miller, Fish & Wildlife Research Institute, Florida Fish & Wildlife Conservation Commission, Gainesville, Florida, USA, karl.miller.bird@gmail.com*

[1] Adrienne Fitzwilliam, Fish & Wildlife Research Institute, Florida Fish & Wildlife Conservation Commission, adrienne.fitzwilliam@myfwc.com

[1] Juan Oteyza, Fish & Wildlife Research Institute, Florida Fish & Wildlife Conservation Commission, juancog@gmail.com

[2] Andrew Schumann, White Oak Conservation, aschumann@white-oak.org

[3] Craig Faulhaber, U.S. Fish & Wildlife Service, craig_faulhaber@fws.gov



In situ field aviary in dry prairie habitat
© Juan Oteyza



Reintroduction of the yellow-shouldered Amazon in Aruba, Caribbean after 77 years of local extinction

Marcela Priscila Franco-Ochoa[1]*, Jack Haines[1], Giancarlo Nunes[2], Roger Solagnier[2] & Natasha J. Silva[2]

Introduction

The *Amazona barbadensis*, commonly known as the Yellow-shouldered Amazon (YSAM), is the only species of its genus adapted to xeric environments. Its natural distribution area includes the countries of Venezuela, Bonaire and Aruba. Aruba is located in the southern Caribbean Sea and is characterised by a tropical steppe, semi-arid and warm (BSh) climate, where YSAM populations were extirpated mainly due the illegal pet trade and persecution as an agricultural pest.

The YSAM is listed as Near Threatened by the IUCN Red List of Threatened Species, included in Appendix I of CITES, and in the specific case of Aruba, the parrot is protected by law under the Nature Ordinance (AB 1995 no. 2, Art. 4 /AB 2017 no. 48).

The IUCN Guidelines for Reintroductions, as well as expert collaborators in the area, served as important resources for the development of this project.

Main Goals

1. Leverage strategic planning and political support to seize key conservation opportunities.
2. Initiate reintroduction of YSAM to Aruba through the release of a founding population.
3. Establish a comprehensive, adaptive monitoring programme for reintroduced YSAM populations.
4. Restore and enhance critical YSAM habitats for long-term survival.
5. Mitigate threats by engaging local

communities through targeted education and outreach.



Evening monitoring in the Arikok National Park to determine the flight path of the parrots to the roosting site © Priscila Franco

Success Indicators

1. Opportunistically secure and release at least 20 YSAM, maintaining a survival rate of over 50% in the first-year post-release.
2. Implement a monitoring programme involving health checks, fecal sampling, and behavioral observations to assess YSAM adaptation and wellbeing.
3. Understand habitat usage by mapping and documenting primary YSAM flight routes, foraging areas, and roosting sites established within the first year of release.
4. Establish a robust native vegetation restoration project, targeting the planting of at least 10 parrot-friendly species before the end of 2024, with expansion and scalability prioritized.
5. Key community members engaged through educational presentations and conservation activities focused on YSAM protection; school group engagement programme developed to increase awareness through social propagation.

Project Summary

Feasibility

The YSAM was extirpated in Aruba in 1947, but an intercepted illegal shipment of 33 YSAM chicks in 2022 created a unique reintroduction opportunity. Responding quickly, the Aruba Conservation Foundation (ACF) led efforts in Arikok National Park to rehabilitate the parrots, collaborating with international experts and government officials. Although large-scale habitat restoration and community engagement were not fully in place, technical support from the World Parrot Trust helped guide rehabilitation and monitoring efforts.

The decision to release this cohort leveraged both the immediate opportunity and long-term conservation goals for the YSAM on Aruba.

Implementation

The YSAM were sampled and treated for gastrointestinal parasites, DNA-sexed, and provided a high-nutrient diet incorporating native species. Health was closely monitored through regular weight, body condition checks, and behavioural assessments for release suitability. Of the initial 33 YSAMs, 25 survived their initial malnourished conditions and underwent human aversion training while being acclimatised to native fruits, nuts, and seeds. After 17 months in care, including 3 months in a pre-release aviary, 25 YSAM were released in three similarly sized groups over a 10-day period. Supplemental feeding was provided at the release site to reinforce site fidelity and flock cohesion.



Feeding station which is next to the pre-release aviary © Priscila Franco

Post-release Monitoring

Post-release monitoring involves twice-daily observations at supplementary feeding stations, with flight paths tracked to assess habitat use. Initially, monitoring was daily, shifting to 5 days a week after 3 months, and then to four times a week starting in July. Observations focus on social group formation, potential breeding pairs, predator response, signs of illness or injury, and wild food consumption.

The ACF Wildlife Hotline enables the public to report YSAM sightings. As of mid-November 2024, three roosting sites and key foraging areas have been identified, with 17 birds regularly spotted in these locations.

Major Difficulties Faced

Biological

Loss of perennial vegetation lands (specifically trees important for YSAM food and shelter), requires long-term supplemental feeding.

The parrots exhibited human imprinting due to hand-rearing and rehabilitation process, leading to high desire to interact with local residents, complicating efforts to encourage wild behaviours.

Seasonal peregrine falcon (*Falco peregrinus*) and merlin (*Falco columbarius*) presence disrupted release attempts, particularly scattering the flock during the second release, which posed a challenge to flock cohesion and site fidelity.

Operational

The project faced an urgent need for additional full-time staff dedicated to YSAM reintroduction to manage rehabilitation, feeding, and monitoring effectively.

Lack of independent, fully equipped facilities for close monitoring during rehabilitation limited capacity to assess health and social behaviours pre-release.

Limited funding for infrastructure and operations challenged efforts to establish consistent monitoring, especially for tracking movement and survival rates in remote areas.

Balancing ongoing habitat restoration with immediate release needs posed logistical difficulties, requiring adaptation to resource and labor limitations.

Broad Underlying Problems

Invasive alien species

- Free-ranging domestic goats (*Capra hircus*) and feral donkeys (*Equus asinus*) heavily graze on natural vegetation, which causes severe ecosystem degradation and reduces essential food and shelter resources for YSAMs.
- Habitat degradation from invasive herbivores also hinders habitat restoration efforts.
- The invasive boa (*Boa constrictor*) poses a potential predatory threat to YSAM; although no direct predation has been confirmed yet, the boa's high population and diverse diet could lead to future impacts especially if YSAM frequent urban areas where boa are predominantly found.

- Control and management of invasive herbivores and invasive and domestic predators are limited by the available funding and political will to address the problems.

- Local awareness and support for managing invasive species are limited, affecting community cooperation for eradication or control efforts in protected areas.

Climate change

- Altered rainfall patterns and shifting onset of rainy seasons affect the availability of water and seasonal food resources, potentially disrupting the parrots' natural foraging cycles.

- Unpredictable weather extremes, such as droughts, reduce flowering and fruiting of native plant species, threatening the stability of YSAM's food sources.

- Long-term habitat resilience is at risk due to climate change, making sustained restoration efforts more challenging and expensive.

Interaction with domestic species

- Uncontrolled populations of domestic, stray, and feral dogs and cats present a predation risk to YSAM.

Major Lessons Learned

- A pre-established Action Plan prioritizing YSAM reintroduction in Aruba enabled rapid response and decisive actions, transforming the initial seizure of 33 YSAM into a pivotal conservation opportunity.

- Political support and willingness to take conservation risks played a significant role in enabling rapid, effective response to the YSAM opportunity.

- Strong multi-sectoral collaboration between the Directorate of Nature and Environment, ACF, and both local and international partners proved essential to achieving the project's first phase.

- Habitat enhancement should be initiated before or in tandem with reintroduction to provide a suitable environment for survival and growth of reintroduced population.



Yellow-shouldered Amazon parrot
© Priscila Franco

- Community involvement is crucial; educational outreach fosters local support and reinforces protection efforts for the YSAM population, and should be ongoing.

- Ongoing reinforcement of the population through breeding programmes, repatriations and translocations will be critical to establishing a resilient and self-sustaining population.

- Expert guidance in monitoring and rehabilitation protocols was invaluable in ensuring that the birds were fit for release and survival.

- Long-term, adaptive monitoring programmes are necessary to asses health, habitat use, and social dynamics in newly released populations.

- Public awareness efforts help mitigate threats by promoting coexistence and appreciation for the YSAM within local communities.

- A flexible, opportunistic approach can be critical in conservation, as unexpected events can provide unique, time-sensitive opportunities to advance recovery goals.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- Effective collaboration among government, local NGOs, and international partners enabled swift response and support for YSAM reintroduction, creating a strong foundation for success; and an adaptive management approach, including flexible response to biological and environmental challenges, allowed the project to overcome setbacks, such as environmental pressures and resource limitations.
- At least 68% survival rate within the first 10 months demonstrates successful adaptation; with 17 of 25 released individuals accounted for and regularly traveling over 6 km daily, displaying cohesive flock behavior.
- Intensive post-release monitoring, health checks and behavioral observations helped identify and mitigate potential issues early, likely influencing survival rates and influencing environmental adaptation, as well as informing both long and short-term conservation planning.
- By December 2024, habitat restoration efforts have been initiated with the planting of 40 specimens of 16 native, parrot-friendly species in key areas, to support natural foraging, reduce reliance on supplemental feeding, and reinforce habitat use patterns; multiple stakeholder workshops were held that brought in habitat restoration specialists from Bonaire addressing scaling-up of the nursery and out-planting efforts.
- Full-capacity attendance at YSAM conservation presentations - engaging over 100 key participants from government environmental staff, nature advocates, parrot keepers, and residents of critical foraging and roosting areas - has significantly boosted local support. This engagement has fostered community awareness, investment, and stewardship while discouraging human-related disturbances, all crucial for the YSAM's long-term protection. Two further targeted neighborhood presentations are scheduled for late 2024, and primary school presentations will engage at least 15 of the most spatially relevant of 37 schools in 2025.

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Author Details

[1] Marcela Priscila Franco-Ochoa. World Parrot Trust USA Inc, 400 S Main St #985, Travelers Rest, SC 29690, USA, mfranco@parrots.org*

[2] Jack Haines, jack@parrots.org

[2] Giancarlo Nunes, g.nunes@acf.aw

[2] Roger Solagnier, r.solagnier@acf.aw

[2] Natasha Silva, n.silva@acf.aw



Population and genetic reinforcement of the Eurasian beaver population in Knapdale Forest, Western Scotland, UK

Helen R. Taylor[1]*, Helen U. Senn[1], Gill Dowse[2], Martin J. Gaywood[3], Ben Harrower[1], Kenny Kortland[4], Sarah Robinson[2], Katarzyna Ruta[1] & John Taylor[4]

Introduction

Following a trial reintroduction of 16 individuals from Norway into Knapdale Forest on the west coast of Scotland (Jones & Campbell-Palmer, 2014), Eurasian beavers (*Castor fiber*) are back in Scotland and listed as Critically Endangered in the UK (Least Concern globally). Subsequently, data showed Norwegian beavers to have relatively low genetic diversity (Senn et al., 2014), raising issues around adaptive potential and inbreeding in Knapdale. The Scottish Beavers reinforcement project aimed to increase the size and genetic diversity of the Knapdale population using individuals with Bavarian genetic material from British ex situ collections and populations arising from illegally released and/or escaped animals in eastern/north-eastern Scotland.

Main Goals

1. Increase the size of the Knapdale beaver population from the 9 individuals known to be alive at the end of the SBT (Scottish Beaver Trial).

2. Increase genetic diversity in the Knapdale population via the introduction of animals with Bavarian ancestry and admixture between animals of Norwegian and Bavarian descent.

Success Indicators

1. An additional two pairs of beavers established and reproducing in Knapdale as a result of reinforcement translocations.

2. The Knapdale beaver population growing to a minimum of five breeding pairs or

family groups.

3. An increase in genetic diversity and a decrease in inbreeding/ relatedness in the Knapdale beaver population.

4. At least one Norwegian-Bavarian cross pairing in the Knapdale beaver population



Beaver release site

Project Summary

Feasibility

Knapdale Forest Reserve was selected as the site for the original Scottish Beaver Trial (SBT) due to suitable habitat and low likelihood of human-wildlife conflict (Jones & Campbell-Palmer, 2014). Surveys of the site in 2017 suggested that there were several vacant suitable territories that additional beavers could be released into (Dowse et al., 2020). At this time, there were an estimated 433 beavers of Bavarian-descent in eastern Scotland (Campbell-Palmer et al., 2018) and a small number in the River Beauly, both arising as the result of illegal releases or escapes, with additional Bavarian-descent animals in ex situ collections within the UK.

Implementation

Animals were translocated from ex situ collections (Wildwood Trust, Kent and Derek Gow Consultancy) or captured in conflict sites in Tayside or Beauly where beavers were causing damage to agricultural land or other property. A total of 21 beavers were translocated into Knapdale for the reinforcement between 2017 and 2019. All animals were translocated via Edinburgh Zoo (n=18) or Five Sisters Zoo (n=3) to ensure disease screening could be performed by vets. Beavers were released as single adults, in pairs and family groups, and in two cases, as lone kits. Small amounts of supplementary food were provided initially for all releases.

Post-release Monitoring

All animals were microchipped prior to release. For each release, the relevant loch was checked 24 hours post-release and then monitored for 6 weeks using camera traps, with a field-sign survey carried out after 14 days. All waterways in Knapdale were also monitored via field sign surveys and camera trapping every 6 months to assess how beavers were using the site and to try and establish survival and reproduction of animals. In September 2019, the team undertook a large-scale trapping and sampling effort to assess which individuals were still present and to collect genetic samples from new (i.e., Knapdale-born) individuals.

Major Difficulties Faced

Biological

Ecological: Predation is not a major issue for adult beavers in Scotland due to the lack of natural predators. However, at least one kit released with its family members during the reinforcement is thought to have been



Beaver being moved to release site

predated (or at the very least scavenged after death), with its skull found out of the water at an elevated position. It was suspected, though not proved, during the reinforcement that Eurasian otters could predate beaver kits and camera trapping footage from beaver releases in a subsequent project Loch Lomond showing otters predating beaver kits have since demonstrated that this can occur.

Anthropogenic: Beavers remain a relatively controversial species in Scotland and are subject to much discussion and management regarding human-wildlife conflict resulting from the damage that beavers can potentially cause to landholdings and fisheries. While the Knapdale site was selected for the original SBT partly due to a low risk of conflict, there are still competing interests in the site, primarily from recreational fishing. During the reinforcement, we recorded at least one instance of a beaver dam being kicked apart seemingly by a recreational angler. This was not a natal dam, and so did not cause substantial issues for the beavers in that area, but it was important to be aware of and attempt to mitigate potential conflict throughout the project.

Genetic: Low genetic diversity was one of the primary drivers of this reinforcement project. In addition, there was known to be an inbred beaver family occupying one of the loch systems in Knapdale; the result of a father-daughter pairing following the death of the original matriarch. The release of Bavarian animals directly into this loch system to break up the inbred family structure was considered, but concerns around potential stress and welfare impacts for individual beavers meant that this was not done. As a result, the inbred family remains in place.

Operational: Many of the translocated beavers were sourced from areas experiencing human-wildlife conflict. This created a relatively high-pressure situation since, if trapping and translocation failed, the next step for conflict mitigation was often lethal control, raising the following challenges:

- More animals needed to be removed from conflict source sites than there was space for within the Knapdale recipient site. This required the reinforcement project managers to push back on pressure to take additional animals that would have had no suitable areas for safe release. The majority of these additional animals were sent to fenced enclosures in England.

- Translocating animals from a conflict site as a pair or family is logistically complex as not all individuals will be trapped on the same day. If the aim is to release a pair/family together to reduce the chance of post-release dispersal, individuals trapped first must be held ex situ while other individuals are trapped. This requires additional facilities and care for those animals, plus a clear cut-off time for when to release the animals being held ex situ and cease trying to trap those remaining at the conflict site if not all animals known to be present have been caught. In two cases, this led to kits being released without their

families to avoid lethal control of these kits. Ultimately, the kits perished following release, likely from stress/ starvation raising the question of whether lethal control would, ultimately have been more humane from an animal welfare perspective.

Social: As mentioned above, the reintroduction of beavers to Scotland remains controversial, in part due to the damage sometimes incurred by agricultural landowners in east Scotland as a result of beaver activity. While the Knapdale reinforcement was, in itself, relatively non-contentious, attitudes towards beavers in Scotland are polarised, the project team engaged regularly with key stakeholder group to address concerns and staff had to be mindful of potential conflict while working on beaver translocations and monitoring in Knapdale.

Broad Underlying Problems

- *Other:* The main ongoing issue for the Knapdale site will always be capacity and dispersal potential. This relatively small site was selected specifically for a trial reintroduction; part of the reason for its selection were the relatively impenetrable barriers to dispersal for beavers, with the Crinan Canal to the north, and the rest of the site surrounded by the sea. As this site reaches capacity, it will be difficult for beavers to disperse and meet with other Scottish beaver populations, which may result in a closed population that requires human-intervention to remain sustainable.

Major Lessons Learned

- Beaver kits should not be released without their family members. Despite great efforts to anchor each of the two kits released alone during the reinforcement while their family members were being trapped (by providing artificial lodges and supplementary feeding and, in one instance, electric fencing to prevent dispersal), both dispersed before their family members could be translocated to



Beaver at release site © Phillip Price

Knapdale and were later found dead. While the intention was to avoid these animals being shot at the source site, the experience proved that releasing kits in isolation is not a viable strategy and raised legitimate questions regarding the welfare implications of lethal control versus translocation in the case of lone kits.

- Artificial lodges and supplementary feeding are not necessary to anchor released beavers to a suitable site. Our post-release data provides little correlation between provision of this kind of support at the time of release and the likelihood of dispersal away from the release site. Some artificial lodges provided were not used at all, but the animals remained at the site. Some animals remained at the release site (and indeed are known to be there several years later) with no initial provision of shelter or food, while others dispersed.

- Following the death of the released kits described above, another trapped sub-adult was deemed too small for release and so was held ex situ for 12 months at RZSS' Highland Wildlife Park to give her the opportunity to grow and for a potential mate to be trapped for her in the following season. This female was released the following year (2019) with a male trapped at a different site. The two animals remained at the release site for

the remainder of the post-release monitoring phase of the project and anecdotal reports suggest they are still there today. Although this was a relatively labour intensive approach in terms of animal care, and not possible for all smaller animals trapped for translocation, it produced a successful outcome.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

Our data show that three of our four success indicators have been met:

- An additional two pairs of beavers have been established and recorded as reproducing in Knapdale as a result of reinforcement translocations (Dowse et al., 2020).
- The Knapdale beaver population has grown to a minimum of five breeding pairs or family groups (Dowse et al., 2020).
- Genetic diversity within the Knapdale population has increased and average relatedness decreased as a result of the reinforcement translocations (Taylor et al., 2024).
- At the end of the project (October 2020), a Norwegian-Bavarian cross pairing in the Knapdale beaver population had not been detected (Taylor et al., 2024). This is not unexpected given that animals were being translocated in pairs/family groups and that beavers can take up to 3 years to leave their family group and establish their own family. We hope that future genetic monitoring of the Knapdale population will establish whether or not this has occurred.

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Author Details

[1] Royal Zoological Society of Scotland, Edinburgh Zoo, 134 Corstorphine Road, Edinburgh, Scotland, htaylor@rzss.org.uk; kruta@rzss.org.uk; hsenn@rzss.org.uk*

[2] Scottish Wildlife Trust, srobinson@scottishwildlifetrust.org.uk

[3] NatureScot, martin.gaywood@nature.scot

[4] Forestry and Land Scotland, kenny.kortland@forestryandland.gov.scot john.taylor@forestryandland.gov.scot



Saving Wildcats (#SWAforLIFE): Early-stage reporting on the conservation translocation of the critically endangered wildcat to the Cairngorms National Park, Scotland, UK

Alice Bacon[1], David Barclay[1], Keri Langridge[1], Roo Campbell[3], Martin Gaywood[3], David Hetherington[2], Kenny Kortland[4], Helen Senn[1]* & Saving Wildcats Team[5]

Introduction

Wildcats in Scotland (Scottish wildcats) are a critically endangered sub-population of the European wildcat (*Felis silvestris silvestris*) and are the last remaining wild felid species in the UK. A status review of wildcat conservation in Scotland by the IUCN SSC Cat Specialist Group (2019) concluded that the free-living wildcat population in Scotland was no longer viable, ostensibly because wildcat numbers were too few, too hybridised and too fragmented, and that recovery would only be possible with the support of conservation translocation projects (see also Campbell et al., 2023).

The Saving Wildcats (LIFE18 NAT/UK/ 000995/ #SWAforLIFE) project seeks to address the decline of wildcats by conducting releases from a captive breeding for release facility into the Cairngorm Connect project landscape (https://cairngormsconnect.org.uk/) of the Cairngorms National Park, Scottish Highlands, alongside threat mitigation.

Due to uncertainty around whether any wildcats remain in Scotland this translocation project is either technically a reinforcement or a reintroduction at a national scale. It is a reintroduction at the scale of the Cairngorms Connect release site. The project is licensed by Scottish Government agency NatureScot (#220946) and follows the Scottish Code for Conservation Translocation which is based on the IUCN Guidelines.

See https://savingwildcats.org.uk/frequently-asked-questions/ for more details of the license.



Overview of release site © Saving Widlcats

Main Goals

To reestablish a genetically and demographically viable wildcat population in the Scottish Highlands and to do this:

1. Reducing threats to wildcats at a release site within the Scottish Highlands.
2. Increasing the population of wildcats at the release site through augmentation.
3. Establishing a source population of wildcats suitable for release in a dedicated conservation breeding for release centre.
4. By supporting the reduction of risk to wildcats across the rest of the Scottish Highlands by developing a framework for the long-term sustainability and socioeconomic benefits of wildcat conservation.

Success Indicators

Release of a minimum of 60 wildcats at suitable release points within the Cairngorms Connect Landscape between 2023 - 2026.

By 2026:

1. All released wildcats have been monitored closely and we have learnt about the factors impacting on wildcat survival and reproduction in the wild.
2. Stable wildcat territories have been established within the project area.
3. Kittens have been born to released wildcat females as a result of mating with wildcat males [and not with domestic cats or hybrids].
4. The wildcat population is genetically diverse and includes wildcat genes from mainland Europe.
5. Local support for the project has been maintained amongst key stakeholders.
6. Through these outcomes, wildcat have moved along the Cairngorms Nature Species Recovery Curve from stage T1 to T3 (https://cairngorms.co.uk/uploads/documents/Final-Report-_Cairngorms-Nature-Action-Plan-2019-2024.pdf)
7. We have substantively improved the scientific knowledge-base for future releases (paving the way for wildcat to move further along the curve to R1-3 beyond 2026).
8. We have used evidence from the releases to generate the next national conservation action plan for wildcat across Scotland, supporting future restoration of the species to landscapes across Scotland (and potentially other sites across the rest of the UK), with a long-term objective of achieving “favourable conservation status”.
9. We have developed an understanding of the economic and cultural benefits of the wildcat’s return.

10. The project has shared its finding to support carnivore restoration across Europe and beyond.

(Success indicators given in Translocation License Application #220946)

Project Summary

Feasibility

Wildcats require a matrix of temperate broadleaf and coniferous forest, scrub and grassland. The release site is estimated to contain sufficient habitat to support a population of at least 40 cats (20 females, 20 male) a population size which is estimated to have a 95% chance of survival over 50 years. Wildcats receive a high level of popular support, there is however potential for conflict with land managers and owners of domestic cats.

Implementation

Releases and post-release monitoring are planned 2023 - 2026 following a preparatory phase 2019 - 2023. In total, the release of 60 individuals is planned. In the first year of releases (June - September 2023), 19 individuals were released from captivity from the dedicated conservation breeding for release centre at the Royal Zoological Society of Scotland's Highland Wildlife Park. Animals are managed with minimal human contact and monitored remotely through CCTV. A soft release methodology with supportive management (supplementary feeding) has been used.

Post-release Monitoring

All released wildcats have been fitted with GPS radio-tracking collars and camera trapping is used extensively for both systematic and targeted monitoring. Released wildcat diet is monitored using DNA metabarcoding and DNA methods will be used to monitor hybridisation with domestic cats. Disease surveillance is being conducted and prey base is monitored. Social attitudes are being recorded. This project is at pre-evaluation phase and monitoring is ongoing. As of August 2024, of the 19 cats released in year 1 (June - September 2023), 16 were still being monitored, 2 were lost to follow-up and 1 was confirmed deceased. The birth of first wildcat kittens of released females was recorded in May 2024; multiple litters have since been detected. Evaluation of hybridisation in the kittens is yet to be made using DNA and pelage analysis. Further



Overview of the conservation breeding and release centre © Saving Widlcats

information about year 1 releases can be found in Langridge et al. (in Press).

Major Difficulties Faced

Biological

Ecological: The suitable habitat within the project area is in close proximity to human populations and associated conflict and threats (see also broad underlying problems).

Ecological: Crashes in the cyclical vole population which is predicted to be in a low in winter 2024 - 2025; impacts to be evaluated.

Climate: During 2023 and 2024 there have been unprecedentedly severe storms and flooding which have constrained project activities; wider ecological impacts yet to be evaluated.

Anthropogenic: See land management activities under Social.

Disease: Disease risk assessment (Bacon et al., 2025) indicates potential threat from Domestic cat viral diseases.

Poison: Disease risk assessment (Bacon et al., 2025) identifies potential risk from anticoagulant rodenticides.

Husbandry: See captive source of wildcats under Behavioural.

Genetic: Hybridisation with domestic cats (Howard-McCombe et al., 2023).

Genetic: The risk of inbreeding in the captive and released population is identified and will increase over time. Inbreeding will need to be alleviated by the introduction of new founders from Europe.

Behavioural: The source of wildcats for releases is from the Scottish Wildcat Conservation Breeding Programme (Barclay & Senn, 2023) and significant resource has been invested into the development of a dedicated conservation breeding for release centre (modelled on the approach of the Iberian lynx project). It is not possible to feed live vertebrate prey in captivity in the UK and to mitigate the risks associated with this, ex situ management protocols have been designed to minimise the risk of maladaptation of animals returning to the wild and supplementary feeding is offered to animal's post-release. Comparative evaluation of ex situ/in situ wildcat behaviour is not yet available at this early stage of the project.

Operational

Captive-breeding: Given the time it takes to breed and raise wildcats, matching the supply of wildcats born ex situ optimally to the needs of the in situ release project is a challenge inherent to a project of this nature.

Logistics: Access limitations on privately owned land slow and complicate pre- and post-release activities.

Social

Social/economic pressures to continue land management activities (sport shooting for game birds, forestry, farming, poultry keeping, tourism) and around responsible cat ownership. Potentially competing conservation objectives with other species. High level of public attention received by wildcats. All human-wildlife coexistence issues require significant engagement and monitoring resource.

Legislative

Wildcats are legally protected. Feral domestic cats are not. However, hybridisation with domestic cats means that reliably distinguishing wildcats from feral domestic cats and hybrids is difficult and the accidental shooting of wildcats misidentified by gamekeepers is a recognised threat. Legal protection of hybrids should be considered.

Lack of compulsory legislation around responsible cat ownership in Scotland (microchipping/neutering/hybrid pets).

In response to the return of wildcats there is now a widespread need to update existing guidance for land managers and for an

updated National Action Plan for the species to support targeted and coordinated delivery of conservation action into the future.

Other

There were significant impacts of the covid-19 pandemic on construction and on the ability to conduct face-face engagement and fieldwork in the earlier phases of the project (1 year project extension granted). The UK's departure from European Union will likely lead to a loss of future EU funding potential.

Broad Underlying Problems

- *Invasive alien species:* Hybridization with domestic cats and disease transfer from domestic cats. Changes in abundance and distribution of feral cats relative to wildcats in recent decades have driven hybridization.
- *Suboptimal habitat:* Scotland is one of Europe's most deforested countries. Historical, wide-spread loss of natural mixed woodland/grassland habitat means that optimal areas for wildcat habitation and prey are fragmented and often in close contact with human communities (see above).
- *Climate change:* Potential for climate change impacts on prey base.
- *Human-wildlife conflict:* The tradition for predator control activities in relation to game management and improvements in the efficiency of predator control technology in recent decades. Identified threats from land management practices in forestry and agriculture.
- *Interaction with domestic species:* See invasive alien species for domestic cat. Wildcat predation on poultry and captive-reared game birds released for sports-shooting.
- *Other:* Decline in rabbit (a non-native, but favoured, prey source) numbers due to infectious disease, habitat loss and population control.

Major Lessons Learned

- This project is still at a pre-evaluation phase.
- A significant ongoing theme in wildcat conservation is the level of resource required to conduct stakeholder engagement in support of threat mitigation.

Success or Failure of Project

Highly Successful	Successful	Partially Successful*	Failure

**The project is currently at a pre-evaluation stage however for the first years of releases it is possible to say that the following success indicators (provided in section 5, above) have been partially achieved:*

1) All released wildcats have been monitored closely [learning about the factors impacting on wildcat survival and reproduction in the wild is ongoing].

2) Stable wildcat territories have been established within the project area [in relation to year 1].

3) Kittens have been born to released wildcat females [genetic status of the kittens yet to be established].

Survival and reproductive success of release cohort 1 is indicative that a suitable conservation breeding and release methodology (see implementation) is in place to support the projects objectives.

Reasons for Success/Failure

- This project is still at a pre-evaluation phase- one year into three planned years of releases.

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Author Details

[1] Saving Wildcats, Royal Zoological Society of Scotland, Highland Wildlife Park, Kincraig, Kingussie, Inverness-shire, Scotland, PH21 1NL, HSenn@rzss.org.uk

[2] Cairngorm National Park Authority,14 The Square, Grantown on Spey, Scotland, PH26 3HG.

[3] NatureScot, Great Glen House, Leachkin Road, Inverness, Scotland, IV3 8NW.

[4] Forestry and Land Scotland, Great Glen House, Leachkin Road, Inverness, Scotland, IV3 8NW.

[5] Saving Wildcats Team: Led by the Royal Zoological Society of Scotland (registered charity number SC004064) in collaboration with NatureScot, Forestry and Land Scotland (FLS), The Cairngorms National Park Authority (CNPA), Norden's Ark, Consejería de Sostenibilidad, Medio Ambiente y Economía Azul de la Junta de Andalucía and with releases being conducted with the support of Cairngorms Connect, Saving Wildcats is supported by the LIFE programme of the European Union. The authors thanks the many staff and volunteers who have contributed to the project.





Guiñas: captive-breeding, rehabilitation & reintroduction in Araucanía, Villarrica-Chile

Fernando Vidal M.[1, 3*], Michelle Reifschneider[1], Florencia Vidal[1], Jim Sanderson[2], Cristián Saucedo[4] & Paula Herrera[5]

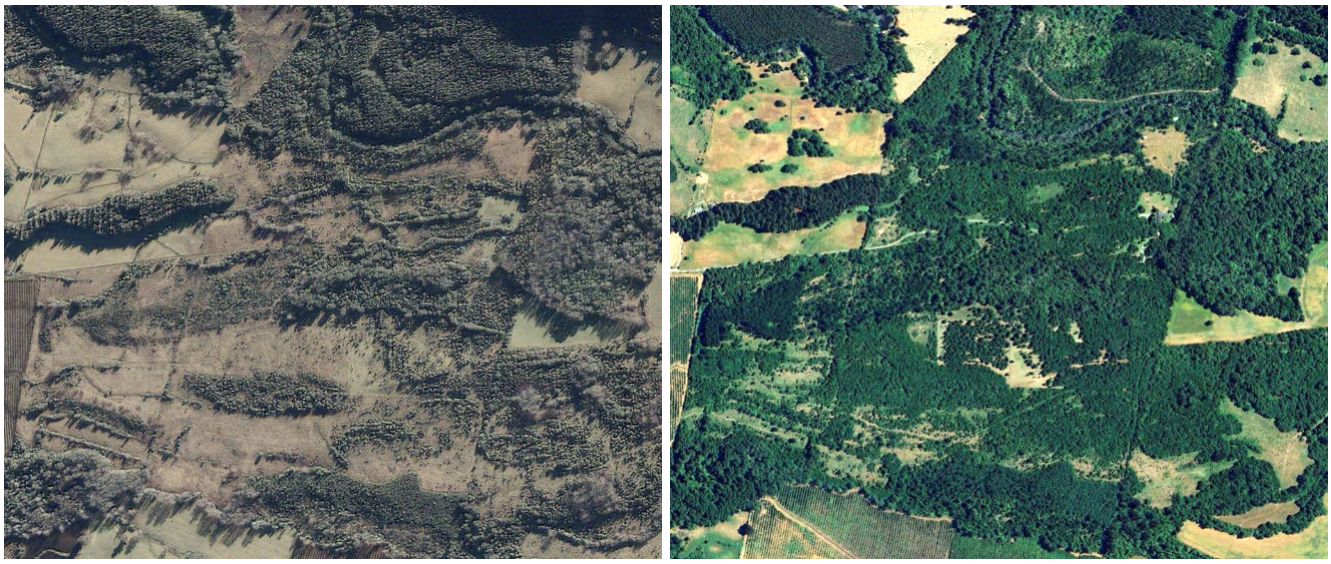
Introduction

Guiña (*Leopardus guigna*) Molina 1782, with a body weight of 1.6 - 2.9 kg, is the smallest wild cat in the Americas and is listed as Vulnerable on the IUCN Red List and CITES II. The guiña occurs in Mediterranean and temperate forests of central and south of Chile (30°-48°S), respectively, as well as in a narrow strip of forest in southwest Argentina. Native primary forest is the principal habitat of the guiña. Primary threats are logging, forest fires, native forest replacement to production forestry, habitat fragmentation and loss, feral dogs, retaliatory killing for poultry losses, and roadkill. Isolated populations are subject to local extinction. Being a lowland species (Vidal F., pers. obs.), its presence is mostly limited by arboreal vegetation availability, not exceeding 1,200 m elevation. The total population of guiña has not been estimated but is likely declining due to habitat loss and low reproductive output.

Fauna Andina centre (S39° 10' 40", W 072° 10' 06") is located in central south Chile at 300 m a.s.l., in Araucania District, on the north coast of Villarrica Lake, where the last remaining of Valdivian forest exists. Where possible, IUCN Conservation Translocation Guidelines have been taken into consideration for the project. However, meeting all the requirements for guiña in Chile proved to be difficult by practitioners. No similar attempts have been made in Argentina.

Main Goals

1. Create a captive-breeding center and establish a local, self-sustaining population.
2. Generate practical knowledge on guiña management and breeding.
3. Generate information about guiña biology



Overview of the release site before reforestation (left) and after reforestation (right)

and ecology.

4. Reintroduce guiña into the private reserve and lowland temperate forest.

5. Convert a farm into a private reserve and promote a biological corridor for the guiña and several sympatric native species.

Success Indicators

1. Rescue, rehabilitate and release individuals, including orphans.

2. Establish a captive population.

3. For the first time, manage and breed guiña in captivity.

4. Release captive-bred individuals to restore a local population.

Project Summary

Feasibility

Most of the land along the southern shores of Villarrica Lake has been deforested, fragmented and urbanised. The conversion of a farm into a reserve on the northern side, with guiñas habitat would create a corridor connecting the few remaining forested lands with public and private properties with suitable habitat. Social perception of guiña is presently positive, the project will use guiña as an umbrella species. There are also other threatened species such as pudu (*Pudu puda*) and puma (*Puma concolor*) that are continuously hunted, trapped and affected by domestic dogs.

Implementation

In 2003, the global conservation programme started in Fauna Andina centre working with several endangered species within their geographic distribution. The project started as a “Breeding Centre” resolution No. 1.490 Servicio Agricola y Ganadero (SAG). The project did not aim to capture “free roaming animals”, but focused on individuals in need of help, such as orphans, illegal trade or rescue animals.

Under the supervision of SAG, the centre received guiñas for rehabilitation or as breeders in case they could not be returned to the wild. Every individual was periodically examined by a skilled veterinarian to check for signs of sickness, weakness, nutritional deficiencies, and abnormal behaviour. The first 3 years were the most difficult, the centre was already working with other target species, but guiña were scarce, but overall academics did not support guiña rescue or the need to keep rescues in captivity. After two years of paperwork and meetings with SAG, the first guiña was obtained.

In 2008, the team began restoring donated land in the area with the goal of rewilding.

With almost no forest remaining, reforestation with native trees was one of the first objectives of the field work. First livestock were removed and control of feral dogs and cats was prioritised. In 2012, the release process of rescued and rehabilitated individuals began. All 3 males and both females given by the Chilean wildlife bureau (SAG) were successfully rehabilitated and released onto the restored land.

Post-release Monitoring

After individuals were released, all were monitored by direct observations that was not difficult since every individual had a long recovery period in captivity under our care. It was not rare that individuals approached us when returning to the centre or even in the field. Trail cameras were used to monitor all individuals while restoration at the reserve continued. Monitoring the interaction of released individuals with the environment and other species present in the area proved interesting and was of long-term value. All the individuals remained in the area, using up to 100 ha of wetlands and riparian forest. Even though they often visited the centre and rehabilitation site, they never looked for shelter or food. They interacted with natural predators such as culpeo fox (*Lycalopex culpaeus*) and puma. One of the males was observed escaping from a culpeo fox by climbing and remaining in a tree. A female was predated by a peuco (Harris's hawk) (*Parabuteo unicinctus*) three years after being released (Vidal F., pers. obs.) and which had a kitten in the wild. The remaining guiña interacted with other wild guiña entering and using the restored land. The second female also produced at least 1 kitten in the wild. The monitoring effort lasted 5 years, showing a mixed population of released individuals and immigrants.

Major Difficulties Faced

Biological

Ecological: Even though 1 female was predated, losses were expected. We were concerned that pressure from culpeo foxes might thwart the reintroduction of guiña as culpeo fox numbers were high because they benefit from human agriculture activities.

Anthropogenic: An NGO, Fundación Los Canelos and a university Pontificia Universidad Católica-Villarrica (PUC), are the actual landowners and donors. They have built trails for ecotourism. Fragmentation of habitat in the middle of the reintroduction core area became an issue affecting guiñas and other endangered species such as pudu.

Other: The landowners and donors (Los Canelos and PUC-Villarrica university) have sold land surrounding the reserve, with the associated sub-divisions and habitat fragmentation for housing.

Legislative

Private conservation efforts do not have strong legal protection for their activities.

Other

Guiña have a naturally low reproductive rate with females reaching maturity in 2 years and produce one kitten every 18 months (unless a kitten is lost). A female with two kittens has never been recorded.

Guiña are also short-lived, likely surviving at most 10 years.

Pairing guiña for breeding is not easy as female guiña chose their own mates.

(Chile has laws protecting all dogs, both domestic and feral and feral dogs in protected areas cannot be removed.

Constant persecution of pumas has removed the top predator of culpeo foxes, domestic and feral dogs that are a principal threat to guiña. When pumas are present, more guiña are recorded and in their absence fewer guiña are recorded.

Global climate change is causing more wildfires in guiña habitat.

Livestock is depleting and degrades natural streams and water sources on which guiña depend.

Broad Underlying Problems

- *Invasive alien species:* Domestic cats, domestic and feral dogs pose a serious threat to Chilean wildlife. Controlling cats and free-roaming dogs in the countryside is demanding since these are a protected by Chilean federal law.
- *Climate change:* This is giving rise to more frequent, devastating fires.

Major Lessons Learned

- Academics do not support captive breeding and reintroduction effort in Chile.
- Weak laws and regulations for private conservation projects.
- Far more time is invested in protecting an already protected reserve.

Success or Failure of Project

Highly Successful	Successful*	Partially Successful	Failure

** a) Rescue, rehabilitate and release individuals, including orphans, b) Create a captive population, c) for the first time guiña were successfully bred in captivity, & d) release of captive-bred individuals to restore a local population.*

Reasons for Success/Failure

- Twelve years of wildlife management experience with a committed team.
- Exotic species detection and removal abilities.
- Twelve years of wildlife captive-breeding experience.
- Successful patrolling which has avoided external threats.

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Not available.

Author Details

[1] Fauna Andina, Centro de Conservación & Manejo de Vida Silvestre, Casilla 102. Villarrica, Chile, fauna.andina@gmail.com*

[2] Small Wild Cat Conservation Foundation.

[3] IUCN/SSC. Conservation Planning Specialist Group.

[4] Fundación Rewilding, Chile.

[5] University Austral of Chile, Patagonia Campus.



Population reinforcement of European mink in Spain

Asunción Gómez[1*], Raquel Godinho[2,3], Javier Pinedo[1], David Lacanal[1], Javier López de Luzuriaga[1], Josu Duran[1], Iñaki Galdós[1], María Díez-León[4] & Madis Põdra[1]

Introduction

The European mink (*Mustela lutreola*) is classified as Critically Endangered by the IUCN and listed in Annexes II and IV (a priority species) of the EU Habitats Directive. Only a few populations remain in the wild, occupying less than 3% of its original range (Põdra *et al.*, 2025). Spain holds one of the last populations of European mink. A severe decline has been observed during the last 10 - 15 years, mainly due to American mink (*Neogale vison*) invasion.

Within the framework of the Life Lutreola Spain project, the American mink was removed from the Ebro basin (Northern Spain), in the territories of La Rioja and Álava. Despite this, the native European mink remained scarce and population reinforcement (following relevant guidelines, IUCN, 2013) with captive bred individuals (from the Spanish National Ex Situ Conservation Breeding Programme) was initiated in 2018.

Main Goals

1. Increase the viability of the European mink population in Spain.
2. Assess the adaptation of the captive bred individuals upon release into the wild (survival rate).
3. Assess the adaptation of the released individuals upon release into the wild (reproductive success).
4. Estimate population trends in the release area.

Success Indicators

1. Post-release survival during the 2 months and 1 year post-release.
2. Breeding of reintroduced individuals in the wild.
3. Increase in population trend (number of



Mink release habitat © Madis Põdra/LIFE LUTREOLA SPAIN

live-trapped individuals) in the release area.

Main Goals

Feasibility

The project took place in two areas within the Ebro river basin: Salburua wetland (Álava) and Najerilla river (La Rioja). The European mink was relatively abundant in both areas in the early 2000s, but numbers declined sharply after the American mink invasion.

In 2014 - 2016, the American mink was removed from these habitats (action carried out in the frame of Life Lutreola Spain project), yet the native mink remained scarce, so population reinforcement was planned. In both areas, the releases were carried out in the framework of the regional (and national) conservation strategy, with approval and oversight of the European mink Working Group in Spain.

Implementation

The project is on-going, with implementation starting in 2018. This study presents the results of 2018 - 2023, releases have taken place over 5 years (2018 and 2020 - 2023, no animals were released due to low breeding success in 2019). A total of 89 individuals have been released, all captive-born within the Spanish ex situ breeding programme for the species. Both soft and semi-hard release methods were used, depending on habitat characteristics. In 2018, the project was financed by Life-programme (Life Lutreola Spain project) and in the following years by regional governments of La Rioja and Álava, municipal government of Vitoria-Gasteiz, and the Ministry for Ecological Transition and the Demographic Challenge.

Post-release Monitoring

Released individuals were radio-tracked for 2 - 3 months to assess their adaptation to the wild. Live trapping was used to evaluate survival 1 year post-release and afterwards. DNA samples were taken from released and live-trapped mink for kinship analyses.

Minimum survival during the 2 month period was 15 individuals (30.6%); 13 were found dead (26.5%). Kaplan-Meier survival estimation 2 months post-release was 68% (CI:51-81%). At least 10 individuals (11.2%) survived over a year. Also, 7 survived over 2 years, 3 over 3 years and 2 up to 4 years. At

least 4 released individuals (3 females; 1 male) reproduced in the wild, two had more than one litter.

Major Difficulties Faced

Biological

Predation: Mainly off-lead dogs and foxes was one of the main causes of mortality, as was anthropogenic trauma - collision with vehicles.

Other: Difficulties with captive-breeding (common problem with this species; Kiik et al. 2013) and small size of the Spanish captive population affected continuity of releases (no animals were released in 2019 for this reason).



Radio-tracking released mink © Madis Põdra/LIFE LUTREOLA SPAIN

Operational

Small size of breeding centres and limited number of pre-release enclosures there, made the release operation less efficient: frequent translocations of the animals were needed, and uniform management/handling during pre-release training was not always achieved.

Greater flexibility in decision-making process (and less bureaucracy) would increase the efficiency of the action, as the release strategy often needs to be adapted to the circumstances.

Continuity of funding is needed for long-term sustainability of population.

Broad Underlying Problems

- *Invasive alien species:* Presence of American mink continues to be the main threat although its removal/control is underway. Evidence suggests if conservation measures are not implemented constantly, the alien mink may outcompete the native one within a few years in both release areas.
- *Habitat quality:* The released mink from time to time appear in human-modified habitat where they can be easily killed by predators.
- *Climate change:* Potentially a long-term problem as increased drought periods and/or unseasonal rain may harm the freshwater habitats, affecting the reproduction and survival of the released animals and overall population recovery of this seasonal breeding species.
- *Interaction with domestic species:* Dogs (and potentially cats) often kill released mink, when they appear close to human settlements.
- *Other:* Monitoring related problems. The European mink is not easily radio-tracked (limited range of signal and life span due to small size of transmitter, and use of habitat), and not all the individuals are detected with live-trapping as the area is large and the species has great dispersal capacity.

Major Lessons Learned

- The removal of the main threat prior to release is key to success in species recovery.
- Preparation of captive-bred animals in captivity (training of each individual in pre-release enclosures) as well as release methods have great importance.
- Captive-bred mink successfully adapted to the wild, the survival rate was similar to that of other studies (Maran et al., 2009) and are able to breed in the wild.
- Five-years' long release operation

resulted in a positive population trend in both release areas.

- Population reinforcement, carried out with captive-bred animals, can be considered as an important tool for conservation of endangered species in the wild
- Particularly successful long-term monitoring on individual and population level, using different techniques, allowed to observe the adaptation of released animals and their participation in the population recovery, including reproduction in the wild.
- Fluid communication and coordination among project participants and stakeholders helps to obtain success in all stages of the project.

Success or Failure of Project

Highly Successful	Successful*	Partially Successful	Failure

** - the project is cautiously evaluated as "successful" in its current phase, although its long-term success depends on the continuity of the conservation measures (preventing the recolonisation of the American mink) in the area.*

Reasons for Success/Failure

- Evidence-based design of the project contributed to the relatively high post release survival for this species. Here, an experience obtained in earlier study in Estonia (Maran et al., 2009) played a key-role, encouraging the building and use of larger (50 m^2) pre-release enclosures in the release sites and breeding centers. Similarly, the survival results obtained in Estonia were of great help in designing the post-release monitoring.
- The use of a combination of methods (live-trapping + DNA analyses) over the 6 years period (2018 - 2023) allowed the confirmation of reproductive success of the released individuals in the wild.
- The positive population trend was observed thanks to effective release strategy and post-release monitoring.
- Both, the successful adaptation to the wild and the partial recovery of the European mink population became possible thanks to removal of the main threat in the release areas, the American mink. Earlier experience showed that the presence of alien mink (even with low density), may easily frustrate the success of release operations (Põdra et al., 2013).

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Author Details

[1] TRAGSATEC, Julian Camarillo 6B, 4A, Madrid, Spain, asun_emink@yahoo.es*

[2] CIBIO/InBIO, Universidade do Porto, Vairâo, Portugal, rgodinho@cibio.up.pt

[3] BIOPOLIS Programme in Genomics, Biodiversity and Land Planning, CIBIO, Vairão, Portugal.

[4] Royal Veterinary College, University of London, mdiezleon@rvc.ac.uk



Reintroduction of the Persian leopard in the Russian Caucasus – northern part of its historical range

Viatcheslav Rozhnov[1], Anna Yachmennikova[1*], Jose A. Hernandez-Blanco[1], Maria Chistopolova[1], Sergey Naidenko[1], Natalia Dronova[1], Irina Voshchanova[2], Alim Pkhitikov[3], Fatimat Tembotova[3], Magomed-Rasul Magomedov[4], Madina Slanova[5], Pavel Weinberg[5], Zaurbek Dzutsev[5] & Sergey Trepet[6]

Introduction

Persian leopard (*P. p. tulliana*) is listed as Endangered under criteria C2a in the IUCN Red List (2023). In Russia, the Persian leopard is included to the Red Data Book of the Russian Federation (Red Data Book, 2021). Its sub-species range include habitats such as forest, savanna, scrublands, grassland, rocky areas (eg. inland cliffs, mountain peaks), sandy areas and semi deserts that are situated in the territory of Afghanistan, Armenia, Azerbaijan, Iran, Iraq, Pakistan, Russian Federation, Turkmenistan, Türkiye and Georgia. Russian Caucasus is the north border of the subspecies range. The last Persian leopards were killed here by locals in the middle of the 20th century - 1952 in Ossetia and in 1956 in Chechnya.

The reintroduction Project was initiated in Russia in 2007 (Rozhnov et al., 2008) and aimed to restore sub-species grouping in the Russian territory to support those leopards that naturally spread to the North part of the range from the South with mates for breeding. The Russian Project on Persian leopard reintroduction was included as an important part in the international project on the Persian leopard subspecies conservation and recovery. The Project was initiated with international support of the IUCN Cat Specialist Group (SSC) and by using EAZA (European Association of Zoos and Aquaria) sources; also IUCN Guidelines for Reintroductions and other Conservation Translocations (IUCN, 2013) were used for this project.



Monitoring of leopards in their natural released habitat

Main Goals

1. *Facility development:* To design and construct specialized breeding facilities that enable zoo leopards to breed and allow their cubs to be raised and trained with minimal human contact, ensuring natural behavioral development.

2. *Captive breeding and rearing:* To establish breeding pairs from the existing zoo population and raise their offspring with the appropriate wild instincts and survival skills necessary for life in their natural habitat.

3. *Pre-release screening system:* To develop a comprehensive assessment protocol for human-trained leopards prior to release. This system will evaluate their ability to hunt effectively, avoid human conflict, and demonstrate a high likelihood of independent survival in the wild.

4. *Managed release:* To reintroduce young leopards into the wild according to genetic management rules, ensuring a sufficient level of unrelatedness. The programme aims to release a founding population of no fewer than 50 individuals to ensure genetic diversity.

5. *Post-release monitoring:* To conduct rigorous monitoring of released leopards to confirm their successful adaptation, including their capability to hunt natural prey, thrive independently, and coexist safely with local communities.

6. *Population restoration:* The ultimate goal is to reestablish self-sustaining, genetically viable leopard populations in the wild that are capable of natural reproduction and long-term survival.

Success Indicators

1. Released animals could survive in the wild more than one full year cycle and avoid human-carnivore conflict.

2. Released animals establish their home range and socio-spatial structure.

3. Leopards breed in the wild naturally and successfully; young leopards disperse in to the natural ecosystem.

Project Summary

Feasibility

The Caucasus is one of the 25 most biologically diverse “hot spots”, it is included



Attaching radio-collars to leopards before release into the wild

in the list of 200 ecoregions of the planet whose biodiversity is important at the global level (CEPF, 2004). It is not easy to implement continuous field monitoring in the habitat where animals are being reintroduced, but it allows keeping wildlife as a whole system close to be untouched in the enough wide areas due to complicated relief. Animals are released in the mountain region, where lowlands are forested, and uplands are alpine areas full of rocks and stony fields. There are two release sites located at a distance of ~315 km from each other (Western and Central Caucasus). Altitude there varies from 1,200 - 1,400 m and a maximum of 2,300 m a.s.l.. Leopards choose their way along either rather gentle slopes, 15 - 20°, or steep ones up to 75 - 80° (Rozhnov et al., 2020).

Historically, people in the Caucasus region usually used any chance to kill leopards because of their direct threat to domestic animals and hunting. The region has a high population density of 60 people/km^2. However, it is experiencing a population decline, characterised by a falling birth rate since 1990 and significant outmigration. The majority of the people in rural areas live near the poverty line and villagers have an additional sources of income such as growing vegetables, raising livestock, fishing and game-hunting. The Caucasus presents a huge diversity of ethnic, religious and cultural types of people. Environmental problems are understood by many locals, due to the high level of education in the region. In most areas the literacy rate is almost 100% but in rural areas people are less informed and environmental issues are poorly covered. Interest in the environment is low, since most people are busy with basic life needs such as food, warmth, fuel and work (Rozhnov et al., 2020).

Implementation

Before release, animals are specially tested for their health and adequacy of behaviour. The area where animals are released has a newly described *Cytauxzoon felis* disease, which could be lethally dangerous, for the leopards. Also there were a number of diseases described in the jackal population and among feral domestic cats (11 pathogens). They are potentially dangerous for unvaccinated leopard cubs born in the wild due the fact that leopards hunt jackals (Naidenko et al., 2021).

The first leopards were released into the wild in 2016 in the Western Caucasus (Caucasian Nature Reserve), with 2 males and 1 female introduced. Since 2018, releases have been conducted across two different sites. Between 2016 and 2023, a total of 15 leopards (8 males and 7 females) were released. These individuals were selected from a group of 27 held at the Sochi Breeding Center. According to the programmes strategy, a total of 50 young leopards are planned for release (IUCN, 2013; Rozhnov et al., 2020).

All released animals were captive-bred and captive-reared in a specially built Sochi Breeding Center. Breeding pairs were provided by EAZA (2 breeding pairs) and 1 wild caught pair (male originated from Turkmenistan, female - from Iran) (IUCN, 2022).

Post-release Monitoring

All leopards were released at 2 years old which is the natural dispersal age of juveniles. They were equipped with GPS-collars (GPS-Iridium-VHF Lotek, Canada; GPS-GSM-VHF Moosefarm, Russia). Kill sites are calculated on the basis of clusters of locations checked during fieldwork. These expeditions are led by highly qualified zoologists to confirm the type of prey killed. A photo traps array is established in the range of the release site in order to observe leopard movements after the collar's battery runs low and to assess the leopards' body condition. Also newcomers, i.e. wild individuals, were detected namely 2 males (Rozhnov et al., 2019; Rozhnov et al., 2020).

Thirteen of the 15 released leopards survived successfully during the first year after release, in all four seasons. They hunt natural wild prey such as ungulates (wild boar, red deer, roe deer, bison cub, chamois, tour) and other prey (jackal, wolf, fox, wild cat, badger, raccoon dog) confirmed in the field (Hernandez-Blanco et al., 2024).

Evidence from GPS tracking and kill-site monitoring shows the released leopards are avoiding conflict with humans. Currently, 9 of the 15 released leopards survive. We have also recorded new wild males on camera traps, indicating that our released leopards are attracting newcomers (IUCN, 2022).

Major Difficulties Faced

Biological

Ecological: We have described a high density of brown bear (*Ursus arctos*) in the Western Caucasus to whom leopards lose their kills. This was not detected in the Central Caucasus (Hernandez-Blanco et al., 2024).

Disease: One female died due the infectious disease (*Cytauxzoon felis*) that has been never described before for that geographical region

Climate: One leopard male has died in the avalanche in the highlands (3,700 m a.s.l.), in the hard weather conditions during a snow storm.

Anthropogenic: One leopard male was lost to a poaching incident.

Operational

Significant issues arose with personnel responsible for leopard training and captive breeding. A critical problem was the concentration of vital decision-making authority in the hands of underqualified staff.

Broad Underlying Problems

Suboptimal habitat: Russian Caucasus is the northern limit of the subspecies range and there are areas where conditions are close to the suboptimal.

Climate change: This can cause the spread of various diseases including the host species such as jackals.

Human-wildlife conflict: People kill leopards due to cultural and traditional reasons so more education is desirable.

I*nteraction with domestic species:* The uncontrolled pasturing of domestic animals makes owners less accountable for their livestock. This, in turn, attracts wild carnivores to prey on these free-ranging animals, which share habitats and behave similarly to wild ungulates. Furthermore, unvaccinated feral cats and stray dogs can transmit dangerous diseases to native wildlife.

Major Lessons Learned

n/a

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- Specalised facilities for captive-breeding were built far from the city and this compared to the initial version allowed the training of captive born leopard cubs without any human contact (*finally success*).
- Genetically matched breeding pairs were selected from the zoo population and transported to Russia. Furthermore, raising cubs to develop natural wild behaviors and to ultimately survive in the wild depends critically on the trainers' techniques. This involves preventing the cubs from imprinting on humans and persistently encouraging them to hunt live prey, a skill they master through repeated practice and learned experience.
- The developed a pre-release assessment system for human-raised leopards is important. This critical measure prevents human-carnivore conflicts involving inexperienced leopards after their wild release. It also protects the project from being discredited by the government and the public.
- Release leopards according to genetic unrelatedness rules, targeting at least 50 individuals; however, only 15 of the planned 50 have been released so far. The project must strengthen its breeding and release efforts to yield sufficient numbers for annual release, as current figures remain too low.
- Monitoring them to prove they are able to survive in the wild, hunt natural wild prey, and avoid conflicts with people. The monitoring method used is highly effective (*success*).
- Restore leopard groupings in the wild which breed naturally and successfully. The project needs to increase the number of well-trained animals released per year - the number is too low now (*not successful*).
- Released animals could survive in the wild more than one full year cycle and avoid human-carnivore conflict mainly due to: i) no human contact during development period for cubs, ii) negative reinforcement of occasional human contact during the special leopard-cub sensitive period, iii) more than 25 successful hunts on live prey before releasing, and iv) never feeding with domestic animal meat (*success*).
- Released animals establish their home range and socio-spatial structure (*success - still in process*).
- Leopards breeding in the wild naturally and successfully; young leopards; natural ecosystem connections and chains recover. A larger number of successfully released leopards are needed (*not successful yet but possibility of improvement*).

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Author Details

[1*] *A.N. Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, Moscow, 119071 Russia,*
felis.melanes@yandex.ru
rozhnov-v-2015@yandex.ru

[2] *Irina Voshchanova, vipposte@mail.ru*

[3] *Alim Pkhitikov, pkhitikov@mail.ru*

[4] *Magomed-Rasul Magomedov, mmrd@mail.ru*

[5] *Pavel Weinberg, tu_r@rambler.ru*

[6] *Sergey Trepet, trepetsergey@gmail.com*





Reintroduction of the Amur tiger in the North-West part of its range, Russia

V.V. Rozhnov[1]*, S.V. Naidenko[1], J.A. Hernandez-Blanco[1], M.D. Chistopolova[1], P.A. Sorokin[1], A.A. Yachmennikova[1], E.Yu. Blidchenko[2], A.Yu. Kalinin[3] & V.A. Kastrikin[4]

Introduction

The former subspecies Siberian or Amur tiger (*P. t. altaica*), was classified as Endangered by the IUCN Red List (IUCN, 2015). In Russia, Amur tiger is included in the Red Book of the Russian Federation (Red Data Book, 2021), as well as in the China Red Data Book of Endangered Animals (Wang et al., 1998). This subspecies range includes habitats comprised of wooded mountains and plateaus and rivers. The climate is humid and belongs to the continental monsoon climate area of the North Temperate Zone, with an annual average temperature of –1 to +1°C, four distinct seasons and a frost-free period of 100 - 120 days.

Suitable Amur tiger habitats belong to the East Asian floristic region of the Manchurian floristic province with a predominance of forest vegetation. The Manchurian flora is the richest and most diverse in Russia, it covers the East Manchurian mountains, the Ussuri-river basin, and lasts along the middle flow of the Amur River. It is characterised by thermophilic and relict forest plant species and includes north temperate flora mixed with subtropical, tropical, and cold temperate flora.

Historical range of the tiger covers mountain systems of the Sikhote-Alin, the Lesser Khingan, and the Changbaishan, as well as the Amur river valley taiga forest area (historical lands of Manchuria). Currently, these territories belong to the Far Eastern region of Russia (Amur, Jewish, and Khabarovsk regions), as well as the northeastern parts of the People's Republic of China (Heilongjiang and Jilin provinces) (Yachmennikova et al., 2023).

The number of Amur tigers in Russia is estimated at no more than 500 individuals in total (Rozhnov et al., 2021). Within the historical range, the number of tigers sharply decreased in the 1950 - 1970s due to direct killing and poaching (Yachmennikova et al., 2023; Rozhnov et al., 2021). Intensive forestry and agriculture activity in that region was carried out during that period. The release project was initiated in Russia in 2012 (Rozhnov et al., 2021) and aimed to restore subspecies grouping in the NW of its natural range in Russia to support tigers that naturally spread to the north from the south with mates for breeding.



Attachment of GPS satellite collar prior to release back into the wild
© J.A. Hernandez-Blanco

The implemented reintroduction project became the basis for further Russia-China cooperation in restoring the Amur tiger across its range. This international project was initiated by both sides in 2016, following the main 2013 - 2015 reintroduction phase in Russia.

Main Goals

1. Construct specialized facilities (a rehabilitation center) to fully enable the rehabilitation of wild-born orphaned cubs. They are prepared for release at age two without human contact.

2. Rescue orphaned cubs found during snowy periods. They are reared and rehabilitated to develop appropriate survival behaviors for the wild.

3. Develop a pre-release testing system to ensure the tigers will be safe for local communities and capable of surviving independently.

4. Ensure all released tigers are genetically tested to confirm relatedness.

5. Monitor released tigers to confirm their survival, ability to hunt natural prey, and avoidance of human conflict.

6. Reestablish a tiger population (or core of the population) in the wild to ensure successful natural breeding.

Success Indicators

1. Released animals could survive in the wild more than one full year cycle and avoid human-carnivore conflict.

2. Released animals establish their home range and socio-spatial structure.

3. Tigers breed in the wild naturally and successfully; young tigers disperse; natural ecosystem connections and chains recover.

Project Summary

Feasibility

The Amur tiger was historically a widespread species (Rozhnov et al., 2021). Over the past 100 years, the range of the Amur tiger in Russia shrank and became fragmented. The tiger was common in the north-western part of its range (the mountains of the Lesser Khingan), but in the Greater Khingan it was extremely rare. Tigers never inhabited the Great Khingan area, but used it as a green



Amur tiger habitat © Yachmennikova Anna

corridor when passing to the Baikal at the beginning of the 20th century.

During that time period, the tiger inhabited the Jewish Autonomous Region, and the western part of the Khabarovsk Territory until the 1970s, when it was wiped out there. Many authors noted that changes in the distribution of the tiger happened very quickly, described in the late 19th and early 20th centuries, and also during the 1960s. In 1950 tiger was still common on the left bank of the Amur River similar to distribution and density at the beginning of the 20th century.

Between 1963 - 1964, the tiger disappeared from the territories along the middle and upper part of the Amur River, also from the Lesser Khingan Mountain area.

Russia's inaugural Amur tiger census in 2005 yielded a critical finding: only one adult male at the edge of its reproductive age was believed to inhabit the entire northwest of its potential range, including the Jewish Autonomous Region and the south of Amur Region.

The habitat in these territories corresponds to the characteristics of undisturbed tiger habitats with an abundant food base (Rozhnov et al., 2021). The high concentration of specially protected natural areas also makes this location suitable for tiger restoration. With rising population numbers, Amur tigers will spread from Khabarovsk northwest into their previous historical habitats, though this expansion will likely take decades.

A faster method is to reintroduce tigers in an area of its range where that species is absent. Reintroduction can be achieved through the translocation of animals from a secure source population to a historical habitat where the species needs to be recovered. The other option is to release animals raised in captivity, specifically trained for life in the wild. The reintroduction of large carnivorous mammals can be considered successful if the released animal hunts successfully in the wild, chooses a habitat as its home range, avoids conflict situations with humans, and breeds successfully.

Implementation

This restoration project consists of 3 key stages: 1) selection and estimation of a suitable restoration site, 2) rehabilitation from starvation and degradation, and training of animals for reintroduction in a special centre, and, 3) release them into the wild with subsequent monitoring using a variety of available methods. Before release, animals are given a thorough health and behaviour screening. The first rehabilitated cubs were released in the Jewish Autonomous Region between 2013 - 2014 into the Bastak nature reserve - one female named “Zolushka”; in Zhuravliny nature refuge - 1 female named“Svetlaya” and the male “Ustin”. In the Amur region in 2014, in the Zhelundinsky nature refuge one female “Llona” and 2 males “Kuzya” and “Boria”. In total between 2013 - 2019, 11 tigers have been released (5 males, 6 females). All released animals were wild born orphaned cubs and they were captive-reared in the specially built Alexeevka Rehabilitation Center for tigers

and other rare animals (Rozhnov et al., 2021).

Post-release Monitoring

To study the dynamics of space usage by released individuals, they were tracked with technological and traditional methods. Technological monitoring included GPS and trailcams. Ground monitoring involved snow-tracking based on data received from GPS collar detected points; inspecting location clusters for kill or rest sites; and deploying a system of trail cameras to cover the area of tiger activity. To study the movements of tigers, we used both Lotek Argos-GPS and Lotek Iridium-GPS collars (Canada), which proved to be the most reliable in our studies.

Kill sites were calculated on the basis of clusters of locations checked during the fieldwork expeditions by zoologists to confirm the type of prey killed. During this time wild tiger males (newcomers) were detected (Rozhnov et al., 2021). Ten out of 11 released tigers survived successfully during the first year after release covering all four seasons. They hunt natural wild prey such as ungulates (wild boar, red deer, roe deer), and other prey such as wolf, badger and raccoon dogs, which was confirmed in the field (Rozhnov et al., 2021; Rozhnov et al., 2019; Mikell et al., 2015). During 2014 - 2015 a total of 110 kills hunted by released tigers were recorded (Miquelle et al., 2025). Only 4% (5 kills) were identified as domestic animals namely 3 stray dogs hunted by tigers in the forest nearby their kill-sites with wild prey hunted by them; and 2 cows (calves) that were free pastured in the forest without human protection. From all tigers' kill sites, the main described kills were as follows wild boar (58%) and roe deer (27%). In summer, badgers (*Meles amurensis*) and raccoon dogs (*Nyctereutes procyonoides*) (4%) were the main prey.

Released tigers avoid human-carnivore conflict as shown from GPS-tracking, one male was detected as a dog-eater; he was recaptured and moved to the zoo. In January 2020, 2 females who were first released in the northwest of the tiger range in 2013 - 2014, Zolushka (aka Cinderella) and Svetlaya gave birth to four broods/litters. Zolushka had the first litter (2 cubs) in September 2015 and the second (2 cubs) in 2017. Svetlaya her first litter (3 cubs) in 2017 and the second one (three cubs) in 2019. In total, monitoring data confirmed that 4 from 5 released females bred successfully in the wild (1 with a released male and others with wild males). Now the grouping in the area of three release sites described has more than 25 tiger individuals and supports itself naturally (Rozhnov et al., 2021; Miquelle et al., 2025).

Major Difficulties Faced

Biological

Ecological: One of released males crossed the Amur River, during the wrong season, when there was heavy snow. It swam across from the wild habitat on the Russian side to a densely populated area in neighbouring China. As a result it preyed on domestic animals, at a later date when it crossed back to the Russian side, it was captured back and moved to the zoo.

Poaching: One tiger male, wild born from one of the reintroduced female born in Russia, was poached by people in a neighbouring country (was found dead with a snare around its neck).

Operational

Unsustainability: The project was plagued by bureaucratic decisions, and as a result some decisions were suboptimal, and these impacted project success. Insufficient funding during the early stages of the project also hindered its development and operational efficiency.

Broad Underlying Problems

- *Suboptimal habitat:* Russian Caucasus is the northern limit of the subspecies range and there are areas where conditions are nearly suboptimal.

- *Climate change:* This can be a reason for disease spread such as African swine fever (ASF), this caused a sharp decrease in the wild boar prey base.
- *Human-wildlife conflict:* Raising awareness is critical, as human activities damage tiger habitats, increase fragmentation, and neglect green corridors. As the tiger population recovers, conflicts will also increase without a change in how people use natural resources.
- *Interaction with domestic species:* There are mainly two main issues i) uncontrolled pasturing of domestic animals make owners irresponsible for them and result in wild carnivores to attack free-ranging domestic animals, and ii) unvaccinated stray dogs also can spread undesirable diseases such as canine distemper virus.

Major Lessons Learned

- Reintroduction can be implemented with minimum mistakes and risks only if all processes are scientifically guided.
- One of the complicated things was to develop the balance among captive-workers and field-workers who are usually almost separated parts of the single team.

Success or Failure of Project

Highly Successful*	Successful	Partially Successful	Failure

** Main tasks and success indicators connected with the project were achieved. Released animals could survive in the wild more than 1 full year cycle and avoid human-carnivore conflict; released animals establish their home range and socio-spatial structure; tigers breeding in the wild naturally and successfully; young tigers disperse.*

Reasons for Success/Failure

- Built special facilities (Rozhnov et al., 2021), situated far from the city, that allows orphaned tiger cubs to recover fully and develop their wild behaviors. They are kept isolated from interactions with keepers (staff of the center) (*success*).
- Develop a comprehensive methodology to raise tiger cubs orphaned by people. This is based on the knowledge of the tiger cubs ontogenesis and behavior (*success*).
- When raising tiger cubs its essential to maintain proper wild behaviors which allows them to survive in the wild. This is only successful when trainers keep in mind all aspects of growth, life cycle and behavior (Yachmennikova, 2017). The criteria are with imprinting and sensitive periods and experience of hunting natural live prey which is necessary (*success*).
- Developed a system of testing young tigers (which were raised and trained by people) before release. This is extremely important and avoids a lot of human-carnivore conflicts for inexperienced young tigers after release into the wild. Also prevents negative criticism on the project from the external agencies (*success*).
- Release tigers following rules to ensure non-relatedness. The current number of released animals is sufficient, evidenced by the regular appearance of wild males (Rozhnov et al., 2021) (*success*).
- Used a successful monitoring system which enable data collection on survival in the wild, hunting natural wild prey, avoiding conflicts with people and successful breeding successfully - used system of monitoring was highly effective Rozhnov et al., 2021; Rozhnov et al., 2019; Miquelle et al., 2015) (*success*).
- Restore tiger grouping in the wild in the North-West part of its range (*success*).
- Released animals could survive in the wild more than 1 full year cycle and avoid human-carnivore conflict by i) never approaching people during the development period of cubs, ii) negative reinforcement of occasional human contact during the special tiger-cub sensitive period, iii) more than 25 success hunts on live prey, and iv) never feeding with domestic animals (*success*).

- Released tigers establish their home range and socio-spatial structure (Rozhnov et al., 2021) (*success*).
- Tigers breeding in the wild naturally and successfully with successful natural juvenille dispersal (*success*).
- Due to habitat destruction the natural ecosystems could be impacted and wild boar based prey resource decreased due to African swine fever (can become a reason of failure of primarily achieved success).

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Author Details

[1*] *A. N. Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, Moscow, 119071 Russia, rozhnov-v-2015@yandex.ru*

[2] *Blidchenko Ekaterina, avulpes@yandex.ru*

[3] *Kalinin Alexander, bastak@yandex.ru*

[4] *Viatcheslav Kastrikin, apodemus@mail.ru*





Re-establishing the Asiatic lion population in Barda Wildlife Sanctuary, Gujarat, India

Mohan Ram[1*], Aradhana Sahu[2] & Nityanand Srivastava[3]

Introduction

The Asiatic lion (*Panthera leo persica*) is a key species in the semi-arid ecosystem of Gujarat's Saurashtra region, India. Once widespread across Asia, their numbers declined due to hunting and habitat loss, confining them to the Gir Forest. Due to timely protection by the Nawab of Junagadh and the Government of Gujarat, their population recovered from near extinction. Today, they are found in nine districts of Saurashtra, covering about 30,000 km^2 (16,000 km^2 as resident range, 14,000 km^2 as visitation range), known as the Asiatic Lion Landscape (Vasavada et al., 2022).

Classified as Endangered by the IUCN and protected under India's Wildlife Protection Act of 1972, their population was estimated at 674 individuals as of June 2020 (Ram et al., 2023).

Main Goals

1. To develop a second home and establish a viable population of Asiatic lions beyond the Gir Forest as a precautionary measure against epidemics, natural calamities, and other anthropogenic factors.

Success Indicators

1. Asiatic lions settle and establish in the Barda Wildlife Sanctuary.
2. Breeding success of the species in the wild.
3. Minimal conflict with resident human population post-release.

Project Summary

Feasibility

Spread over 192.31 km² in Gujarat's Porbandar and Dev-Bhoomi Dwarka districts, Barda Wildlife Sanctuary is crucial for Asiatic lion conservation (Jhala et al., 2014). It is located ~15 km northeast of Porbandar city. Due to its eco-climatic similarities with the Gir Forest, scientific studies have identified it as a potential habitat for the Asiatic lions. Historically, Asiatic lions inhabited Barda Wildlife Sanctuary until 1879 (6 individuals were hunted down), and recently, a male Asiatic lion naturally dispersed to the sanctuary, highlighting its potential as a key dispersal and conservation area.



Wildlife veterinarians and field officials deploying a radio-collar on a female Asiatic lion

Implementation

In January 2023, a male Asiatic lion naturally recolonised Barda Wildlife Sanctuary for the first time since 1879, using a coastal corridor. To re-establish the lion population, authorities approved the reintroduction of some individuals. Between March 2023 and February 2024, 5 females of different ages were released into the sanctuary after being quarantined to help them adapt.

Veterinarians and their team monitored their health, and once ready, the lions were deployed with GPS collars for post-release tracking. The females were selected from different areas to maintain genetic diversity and strengthen the sanctuary's lion population.

Post-release Monitoring

After their release, the females were closely monitored using visual observations and GPS collars. For the first month, the collars transmitted data every hour and recorded their locations every 30 minutes. After this period, the transmission changed to every two hours while maintaining location recording. If a collar malfunctioned or the battery drained, it was replaced immediately. The lions were tracked using VHF signals if the collars lost satellite communication. Experienced veterinarians, wildlife trekkers, and staff from the sanctuary monitored the lions daily. All females adapted well to the sanctuary and established stable home ranges. Camera traps were also set up in high-movement areas to track their movements and activities.

Major Difficulties Faced

Operational

The hilly terrain of the sanctuary paused a challenging task in on-ground monitoring of the individuals.

Vegetation variations in different areas of the sanctuary hindered easy movement.

Sometimes, intermittent transmission from collars, due to thick vegetation in some areas and terrain, made monitoring the individuals difficult.

The limited accessibility and interconnected road network.

Broad Underlying Problems

None reported.



Habitat of Barda Wildlife Sactuary

Major Lessons Learned

- Need to reduce quarantine and acclimatization time.
- The “soft” release strategy for reintroduction has been very successful.
- Releasing a smaller group size (2 - 3 individuals) is beneficial for effective monitoring and management. Releasing a larger group may undergo the fission process, making tracking, monitoring, and management difficult.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- The area had a historical presence of the species and was, therefore, highly suitable, which scientific studies have validated.
- The released individuals quickly acclimatized and established territories within the sanctuary, demonstrating their adaptability and the success of the project.
- Three of the 5 females released have reproduced, a promising sign for the establishment of individuals in the area.
- Though there are some nesses (temporary human settlements) in some areas of the sanctuary, there were no instances of human-lion conflict, ensuring the safety and coexistence of the species.

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Author Details

[1] Deputy Conservator of Forests, Office of the Deputy Conservator of Forests, Wildlife Division, Sasan-Gir, Gujarat, India, mrlegha@gmail.com

[2] Chief Conservator of Forests, Gujarat, India, aradhanasahuifs@gmail.com

[3] Principal Chief Conservator of Forests & Chief Wildlife Warden, Gujarat India, nityanandforest@gmail.com



Reintroduction of Mt. Kenya guereza to Karura Forest Reserve, Kenya

Peter Fundi[1,2*], Harvey Croze[3], Chantal Mariotte[3], Thomas Kariuki[4], Stanislaus M. Kivai[2] & Charles Musyoki[5]

Introduction

Mount Kenya guereza (*Colobus guereza kikuyuensis*), like other species in the subfamily Colobinae, are leaf-eating, charismatic Old World monkeys (Groves, 2007) whose pelts are highly regarded culturally. Despite being endemic to Kenya and confined within few isolated highland forest patches, the Mt. Kenya guereza is currently listed as Least Concern.

The subspecies inhabits eastern Rift Valley forests including Mount Kenya, Aberdares, Ngong Escarpment, and other highland forest remnants (Butynski et al., 2013). Habitats outside protected areas are experiencing increasing human disturbance (Fashing & Oates, 2013) with severe fragmentation and extirpation throughout the range impacting negatively on group structure, behaviour and ecology (Butynski & De Jong, 2014).

In Kipipiri, Nyandarua County, riverine ecosystems support a healthy population with an uncertain future due to rapidly expanding irrigated agriculture. The resulting human-colobus conflicts creates a strong case for translocation as a conservation tool (Seddon et al., 2007). Hence, under IUCN guidelines on primate translocation, from 2014 - 2016 over 24 vulnerable groups were captured and released in Karura Forest Reserve (-1.246921°S, 36.816895°E), an urban forest within Nairobi traditionally held to have hosted the sub-species in the 1960s.

Main Goals

1. Use translocation to rescue guereza groups from alienated habitats.
2. Use translocation to resolve human-nonhuman primate conflicts.
3. Enhanced faunal diversity and visitor experience in a previously degraded

urban forest.

4. Tested and documented guereza translocation procedures to inform future operations.



Moving a group of Mt. Kenya guerezas to the holding cage at Karura forest © Harvey Croze

Success Indicators

1. Successful capture and release of 26 target groups as family units.
2. Acclimatization, groups' cohesion, and 50% survival rate.
3. Occurrence of births 2 years after release.
4. Decline in human-nonhuman primates conflicts at the capture sites.
5. Increase in visits to Karura Forest by visitors interested in primate viewing.

Project Summary

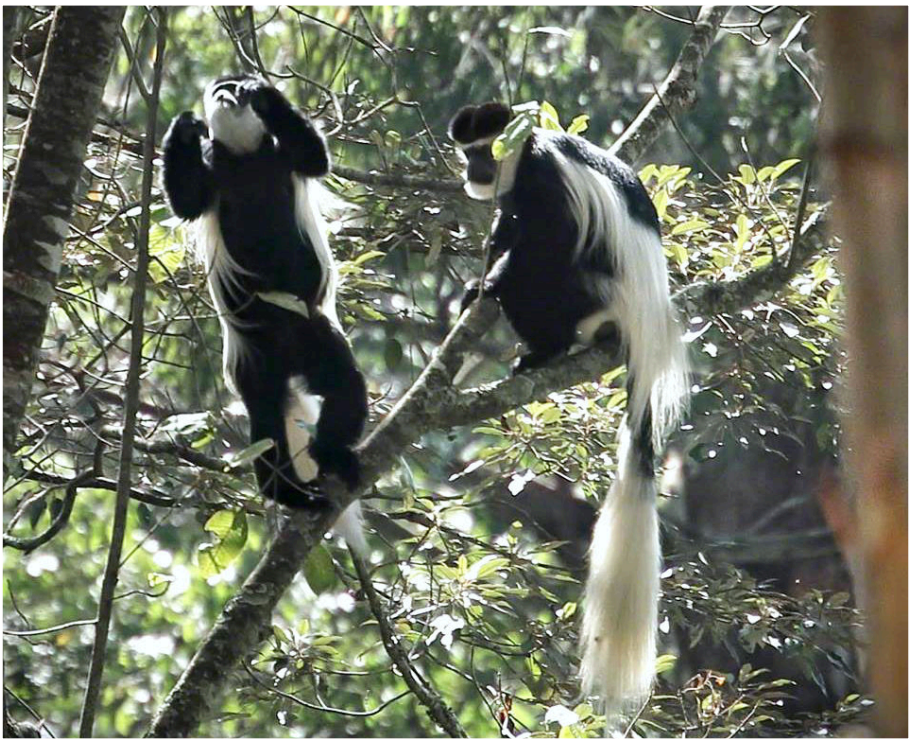
Feasibility

In the Kipipiri area in central Kenya, just southwest edge of the Aberdares National Park, riverine guereza habitats have been cleared and fragmented to create room for irrigation agriculture. Although guerezas are arboreal primates and therefore inherently difficult to trap or immobilise safely and effectively, the nature of the remnant habitat of the target groups was such that they were conveniently concentrated in relatively low, sparse vegetation. Family groups were left hanging on remnant bushes that could barely sustain their requirements forcing the monkeys to turn to crop raiding.

Implementation

Translocation was adopted to mitigate human-wildlife conflict and save the surviving family groups. The exercise involved habituating, monitoring (behaviour and demography), and capturing targeted problem groups, then relocating them to Karura Forest Reserve, well within the species range and devoid of agricultural activities. The project was undertaken by the Institute of Primate Research (now Kenya Institute of Primate Research) in collaboration with the Kenya Wildlife Service and the Friends of Karura Community Forest Association, and under a capture and release permit from Kenya Wildlife Service.

Capture-and-release was followed by pre-translocation mapping of conflict hotspots and gastrointestinal parasite surveillance. The capture plan was designed ensuring whole family unit was captured and released hence quick establishment at the new site. A particular group's plant food selection was assessed for potential matching in both the source and release sites. Twenty-six groups were identified and earmarked for translocation.



Male and female Mt. Kenya guerezas at Karura forest © Harvey Croze

Habituation of the first group to trap cages commenced in February, 2014 using bait materials derived from food crops cultivated in the farms. Habituation lasted between 3 - 15 weeks depending on group size and cropping season. Capture was done early in the morning lasting between 3 - 8 hours, and individuals were transported in the same capture cages. A total 122 individuals in 22 family groups were captured and released in Karura Forest in three phases up until March 2016. Groups were acclimatised in a holding cage for three nights at the release site before release. Community sensitisation was also conducted at the capture and release sites to address any conflict of interests and promote harmonious coexistence.

Post-release Monitoring

The 22 groups successfully released in Karura forest have been monitored for the last 7 years. Data on feeding, ranging pattern, group location, demographics information and association with other primates has been consistently recorded. Post-release data indicate that all the groups established stable home ranges along the riverine habitats adjacent the holding cage 3 - 6 weeks after release. Although group home ranges overlapped, intergroup aggression were not observed. The first birth at the new site was reported in February 2015, 1 year after initial release. As of December 2022, a total of 87 births have been recorded, a good indication of reproductive success for the translocated population. Nine deaths occurred during the translocation period, and 18 deaths in the last 7 years, well within the range of natural population attrition (King et al., 2014).

Major Difficulties Faced

Biological

Selection of suitable habituation bait due to differences in bait preference within and between groups.

Miscarriage of pregnant females while in the holding cage especially if held for more than three nights.

Selection and nutritional balancing of dietary needs while in the holding cage potentially leading to carbohydrate toxicity.

Having come from an area dominated by shrubs, most individuals lacking skills to jump across canopy leading to falls from trees and a handful of associated deaths (five fatal falls).

Operational

Difficult terrain inhibiting use of the large and more effective capture cages and limiting choice of suitable cage placement site for habituation and capture.

Delays in habituating and capturing adult males within the group due to their cautious nature, typically being the last individuals to feed from the cages.

Locating the exit door during release being problematic for some individuals affecting the simultaneous release of the group.

Broad Underlying Problems

- Riverine habitat loss and fragmentation.
- Human-colobus conflicts.
- Human population increase and associated land subdivision.
- Climate change necessitating a shift to irrigated agriculture.

Major Lessons Learned

- Habituation requires an understanding of individual's bait preference and normally takes time depending on group size, availability of food crops in the farms, and availability of wild foods.
- Necessity of having a large holding cage (9.1 x 6 x 4.8 m) that can incorporate trees inside to enhance adaptation to arboreality and minimize tree falls after release.
- Positioning the exit door on the roof of the holding cage to enable the groups to leave simultaneously and maintain group cohesion.
- Well-formulated translocation guidelines and careful design and execution of translocation plan is key to successful capture and release of colobus guereza with minimal mortality rate.
- Pre- and post-translocation ecological monitoring of the groups is necessary for documenting species translocation successes and failures.

Success of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- Collaborative planning and cooperation from key stakeholders including the Kenya Forest Service, the Kenya Wildlife Service and the local community both at the capture and release sites enhanced the smooth translocation exercise.
- Adoption of soft release of the relocated groups enabled them to acclimatize to the new habitat, maintain group cohesion and settle in areas adjacent to the holding cage hence avoiding the community areas adjacent the forest.
- Mount Kenya guerezas are largely folivorous relying on young leaves and fruits for their diet and so require small home ranges. They are also highly adaptable in an indigenous forest within their geographical range. Karura Forest Reserve adequately met those requirements.
- Decision to minimize stress by capturing, transporting, holding, and gradually releasing together individuals from the same social unit was key to minimizing stress related mortality during translocation. Low mortality rate of 2.8% in the pre-release phase was a notable success in this project.

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Author Details

[1,2] Chuka University, Department of Environmental Studies and Resource Development, P.O BOX 109-60400, Chuka, Kenya, pfundi@chuka.ac.ke*

[2] Kenya Institute of Primate Research, Conservation Biology Department, P.O BOX 24481-00502, Karen, Nairobi, Kenya, skivai@gmail.com

[3] Friends of Karura Community Forest Association, Po BOX 63402-00619, Nairobi, Kenya, chantal.mariotte@gmail.com hcroze@gmail.com

[4] Science for Africa Foundation, P.O BOX 50877-00100, Nairobi, Kenya, t.kariuki@scienceforafrica.foundation

[5] Kenya Wildlife Service, P.O BOX 40241-00100, Nairobi, Kenya, cmusyoki@kws.go.ke



Reinforcement of Mount Kenya guereza population at Soysambu Conservancy, Kenya

Peter Fundi[1,2*], Kathryn Combes[3], Fred Omengo[4], Geoffrey Bundotich[4] & Linus Kariuki[5]

Introduction

Black and white colobus (*Colobus guereza*) belongs to a group of old world monkeys in the subfamily colobinae, commonly referred to as the leaf eaters (Groves, 2007). The subfamily colobinae is divided into five genera including *Colobus guereza*, *C. vellerosus*, *C. satanas*, *C. angolensis* and *C. polykomos*. The species *C. guereza* is endemic to Africa and IUCN has listed eight subspecies in the continent. In Kenya there are three subspecies of *C. guereza*, namely, Mau Forest guereza (*C. g. matschiei*), Mt. Kenya guereza (*C. g. kikuyuensis*), and Mt. Uarges guereza (*C. g. percivali*).

The Mt. Kenya guereza is endemic to Kenya's highland forests and of least concern as per the IUCN Red Listing. The species inhabits a wide range of forest types and is well adapted to disturbed forests (Fashing & Oates, 2013). However, crop farming activities and heavy human presence within agro-ecosystems drives these highly adaptive primates into conflicts with farmers (HernáNdez-García et al., 2009) prompting translocation of vulnerable groups. In 1999, a total of 14 Mt. Kenya guereza individuals threatened by habitat loss in Kipipiri riverine ecosystems were translocated to Soysambu Conservancy. Due to the small population size, growth in numbers remained slow while inbreeding possibility remained high. This prompted the need to supplement the population while boosting genetic diversity.

Main Goals

1. Relocate the guereza populations inhabiting degraded riverine ecosystems in Kipipiri sub-county, Nyandarua County.
2. Increase genetic viability of the guereza population at Soysambu Conservancy.
3. Mitigate human-guereza conflict at Kipipiri agro-ecosystems.

Success Indicator

1. Released group's settlement in areas occupied by resident population.
2. High post-release survival and successful reproduction.
3. Mixing of released individuals with resident populations.
4. Reduced human-guereza conflicts at Kipipiri agro-ecosystems.



Mt. Kenya guereza capture at Kipipiri
© Peter Fundi

Project Summary

Feasibility

Following the alarming report of dwindling guereza population in Kipipiri Division in the year 1999, a translocation exercise aimed at rescuing threatened individuals and groups was initiated by Wakuluzu Colobus Trust (current Colobus Conservation). A total of 14 individuals in five groups comprising of 3, 2, 1, 1, and 7 individuals were released at Soysambu Wildlife Sanctuary (Conservancy) along the forested shores of Lake Elementaita. Eighteen years later, a follow-up survey of the population was conducted in 2017 and reported 19 individuals in four small groups. The slow pace in population growth necessitated a population supplementation plan in order to boost the population's genetic diversity. Still, the riverine habitats for guereza population in Kipipiri continued suffering degradation owing to rapid human population increase and climate change. Translocation was therefore used to assist the vulnerable groups disperse to suitable habitats within their range.

Implementation

A team drawn from the Institute of Primate Research (now Kenya Institute of Primate Research) and Wildlife Research and Training Institute in collaboration with Kenya Wildlife Service identified 15 vulnerable groups within Kipipiri agroecosystems and planned for their habituation and capture; and release at Soysambu Wildlife Conservancy.

Pre-release habitat assessment of the Soysambu's forested area along the lake was conducted in February 2017 to evaluate food availability and predator presence. The guereza population at Kipipiri was also surveyed to determine group's composition and gastro-intestinal parasites load. Locally available foods from the farms were used to habituate and capture the groups. Between July 2019 and January 2021, a total of 83 individuals in 11 family groups were captured and confined for three nights in a holding cage constructed within Soysambu's forested area to acclimatise prior to release.

Post-release Monitoring

For a period of one year post-release, all the released groups were monitored on a daily



Colobus guereza kikuyuensis © Peter Fundi

basis to determine group size and composition. The groups were also monitored for dietary selection and ranging pattern by a trained local research assistant and a team of ecology students drawn from local universities.

Upon release, guereza groups formed polyspecific associations with the resident Sykes monkeys (*Cercopithecus mitis kolbi*) learning the food rich areas, water sources and sleeping sites. The association eased their choice of suitable territories and settlement within the forest. Unlike in an earlier reintroduction of the subspecies to Karura forest, cases of tree falls were not recorded and only three deaths occurred resulting from colon prolapse, pneumonia infection and crowned eagle predation of a juvenile male. By November 2021, a total of 17 births had been recorded in both resident and released groups. Three instances of resident guereza group takeover by released males was recorded signalling possible outbreeding and gene diversification.

Major Difficulties Faced

Biological

- Presence of easy to habituate Sykes monkeys at the capture sites hence captured before guerezas.
- Presence of leopards at the capture site prolonging guereza habituation.
- Limitations during post-release monitoring due to presence of dangerous wild animals.
- Presence of predators in the release site especially leopards and crowned eagles affecting group's settlement.

Operational

- Tough terrain at the capture site.
- Funding challenges occasioned by COVID 19.

Broad Underlying Problems

- Changing land use due to global climate change.
- Group size and composition in the 1999 translocation.
- Human population growth at the capture sites.

Major Lessons Learned

- Pre-release monitoring is critical to understanding group dynamics of the released population.
- Presence of conspecifics boosts translocation success.
- Pre-release habitat assessment helps determine location of acclimatization cage.
- Pre-release acclimatization period should be brief to minimize miscarriages.

Success of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- Integration of released groups in areas already occupied by resident colobus monkeys.
- Polyspecific association with resident Sykes monkeys guided the groups to food rich areas of the forest.
- High and diverse food availability at the release site.
- Adequate funding to support long term field work under unpredictable situations.

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Author Details

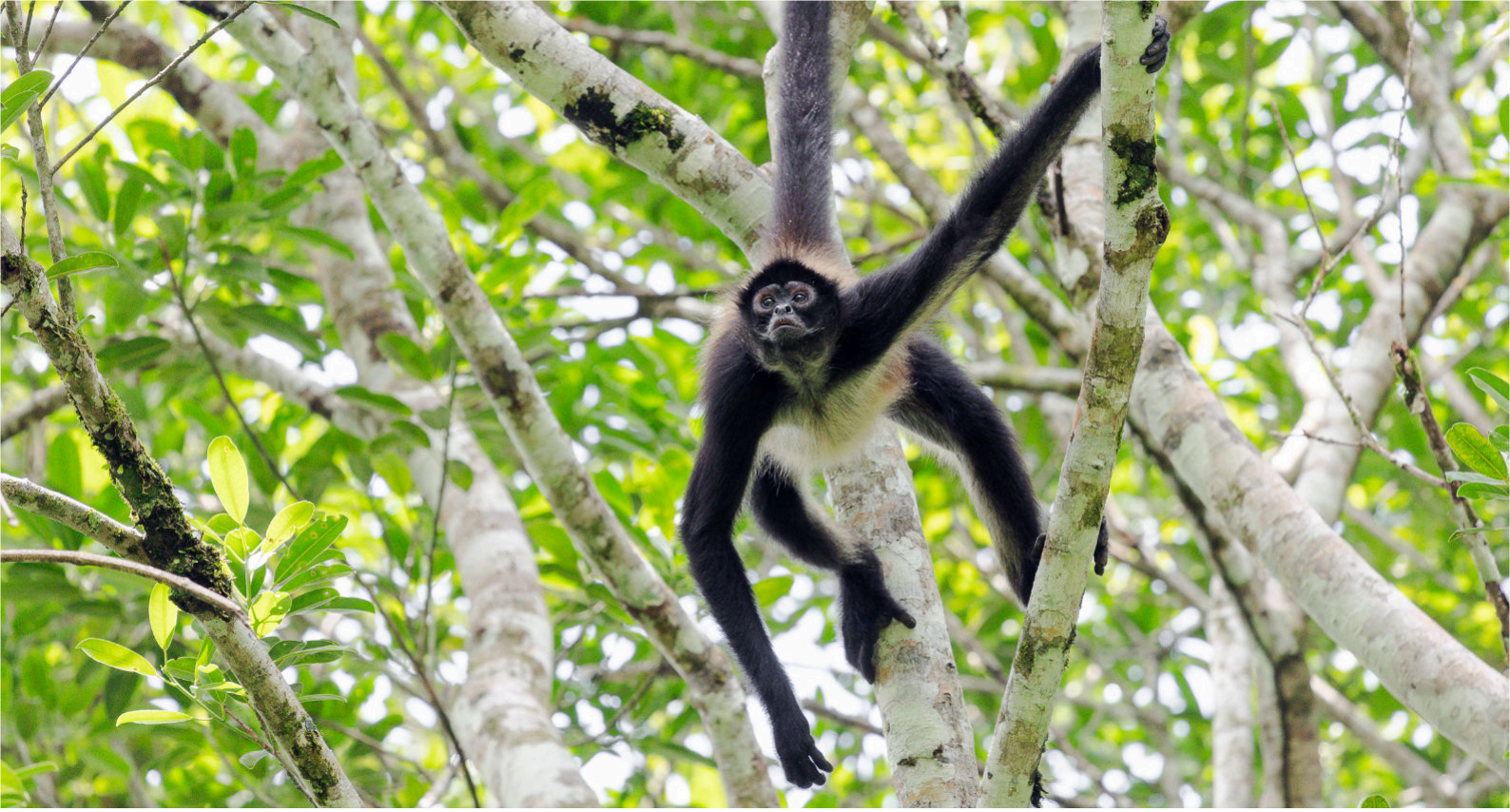
[1,2*] *Chuka University, Department of Environmental Studies and Resource Development, P.O BOX 109-60400, Chuka, Kenya,*
pfundi@chuka.ac.ke
peter.fundi@gmail.com

[2] *Kenya Institute of Primate Research, Conservation Biology Department, P.O BOX 24481-00502, Karen, Nairobi, Kenya.*

[3] *Soysambu Conservancy Ltd, P.O BOX Private Bag, Nakuru, Kenya,*
kcombes@soysambuconservancy.org

[4] *Wildlife Research & Training Institute, P.O BOX 842-20117, Naivasha, Kenya,*
fomengo@gmail.com
geoffreybundotich@gmail.com

[5] *Kenya Wildlife Service, P.O BOX 40241-00100, Nairobi, Kenya, lkariuki@kws.go.ke*



Rehabilitation and reintroduction of black-handed spider monkeys in Mexico

Ana María Santillán-Doherty[1], Gilberto Pozo-Montuy[2], Guillermina Jana Hernández-Cruz[1*], Beatriz Alejandra González-Hernández[1] & Braulio Pinacho-Guendulain[2]

Introduction

Black-handed spider monkeys (*Ateles geoffroyi*) are native to Mexico and classified as Endangered on the IUCN Red List and in Appendix II of CITES. Mexican legislation also recognises them as endangered. If deforestation continues, *A. geoffroyi* could lose 34% of its habitat and see a 50% population decline by 2063, alongside threats from illegal hunting and trafficking (Cortez-Ortíz et al., 2020). In this re-introduction project, confiscated wild-born spider monkeys have been rehabilitated by the Mexican Centre for Primate Rehabilitation NGO (CMRP) in a Flora and Fauna Park in Veracruz. The first reintroduction has taken place in Nuevo Malzaga, Oaxaca, in partnership with Usumacinta Biodiversity Conservation NGO (COBIUS), the National Commission of Natural Protected Areas (CONANP), and the local community.

We used the IUCN Guidelines for Nonhuman Primate Reintroductions (Baker, 2002) and the Management of Confiscated Live Organisms (Maddison, 2019).

Main Goals

1. To act as an initial step in establishing a long-term viable population of spider monkeys in Nuevo Malzaga, Oaxaca, Mexico.
2. To improve the welfare level of the rehabilitated spider monkeys by providing a suitable release site, with opportunities to express natural behaviors.
3. To perform pre- and post-release assessment and monitoring of the spider monkeys and their habitat, involving the local community.
4. To generate work opportunities for the local community.

Success Indicators

1. The spider monkeys have been assessed as healthy, free of zoonotic diseases, and behaviourally fit to be reintroduced back into the wild.

2. The habitat has been assessed and deemed suitable for the establishment of a long-term viable population of spider monkeys.

3. The spider monkeys have been released safely and following international guidelines and national regulations.

4. After the release of the spider monkeys, there has been group cohesion and expression of natural behaviours.

5. The local community has been involved in the release and post-release monitoring of the spider monkeys.



Spider monkey habitat with community members © Ricardo Torres-Flores

Project Summary

Feasibility

The selected reintroduction area is the Area Voluntarily Designated for Conservation (AVDC) Nuevo Malzaga, a 660 ha National Protected Area within the historic range of *Ateles geoffroyi*. A comprehensive habitat survey has been carried out with the support from the trained local community, other organisations, and volunteers. The sampled vegetation corresponds to tropical evergreen rainforest and contains several primary food sources for spider monkeys (e.g., *Brosimum alicastrum*). The trees in the upper canopy are over 30 m tall, and frequently reach heights of 65 - 75 m. The ecosystem will require continuous assessment to ensure the project's sustainability.

Implementation

Two individuals were reintroduced in Nuevo Malzaga in August 2024. They were wild-born ex-pet adult females, rehabilitated since infancy and kept in a pre-release 0.25 ha enclosure at the Flora and Fauna Park of the University of Veracruz (~188 km from the reintroduction site), for 10 years prior to their release. Pre-release health and behavioural assessments were conducted alongside habitat surveys with support from the local community. There were no concerns about the suitability of the individuals or habitat for release. Several additional reintroductions are planned in Nuevo Malzaga in the next 10 years.

Post-release Monitoring

The reintroduced individuals are being monitored with the involvement of the local community. This includes conducting behavioural observations and establishing permanent routes to record their behaviour. The monkeys have also been fitted with very high frequency (VHF) telemetry collars to build a geographical information system

containing data on the distribution and location of the reintroduced animals. We aim to obtain novel indicators of the spider monkeys' adaptability to new habitats and/or potential welfare issues. The current and future release groups will be monitored for 5 years post-release.



Spider monkey at release site
© Cobius AC/Ricardo Torres-Flores

Major Difficulties Faced

Biological

Environmental hazard: Fires are considered an environmental hazard in the AVDC Nuevo Malzaga. One of the goals of the reintroduction project is to protect this area against fires.

Behavioural: Some monkeys fare better in rehabilitation programmes than others. We evaluate these differences and release only those who are behaviourally fit.

Operational

Obtaining enough funding and other resources for rehabilitation, reintroduction, and post-release monitoring has been challenging.

Social

It is necessary to inform neighbouring communities about the presence of released spider monkeys, so they can contribute to their protection.

There is a need to enhance discussion and interest among Mexican primatologists in using rehabilitation as a conservation strategy.

There is a need to raise public awareness regarding the negative impact of the illegal pet trade in the welfare and conservation of spider monkeys in Mexico.

Other

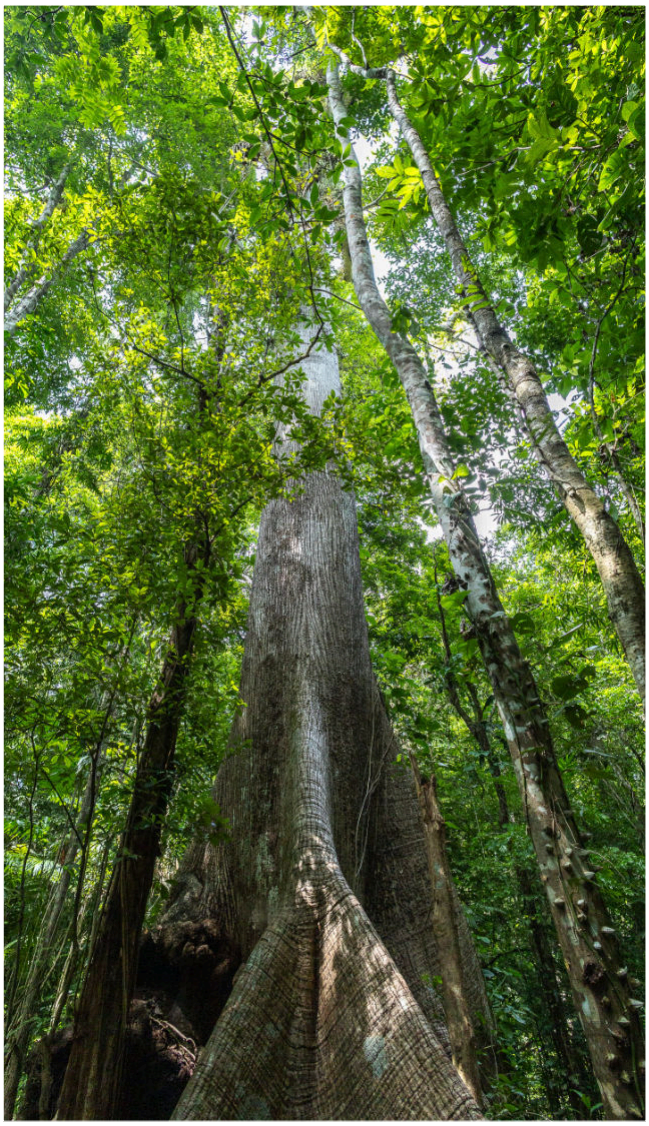
Inaccessible areas within the region complicate post-release monitoring, and we have observed a decrease in detection capacity via telemetry.

Broad Underlying Problems

- *Suboptimal habitat:* Some areas have already been impacted by fire; however, they are currently in a state of restoration.
- *Climate change:* Potential droughts could pressure the released monkey population, as their ability to memorise the locations of tree trunks and water sources may be affected.
- *Other:* Possible natural predation.

Major Lessons Learned

- Close monitoring before release ensures all reintroduction candidates are healthy and display appropriate behavioural patterns.
- Undergraduate students and volunteers provide essential support in pre-release monitoring and husbandry-related practices during rehabilitation.
- A pre-release enclosure (~0.25 ha) aids in developing species-appropriate behavioural patterns, but high costs and



Spider monkey release site
© Ricardo Torres-Flores

availability of resources may be challenging.

- Wild-born spider monkeys rehabilitated from an early age are suitable candidates for reintroduction. Further studies should also include adult-confiscated individuals.
- Local communities can provide essential support in habitat surveying and post-release monitoring and should be included when planning reintroduction projects.
- Surveillance and fire prevention action must be taken to protect the reintroduced individuals and their environment.
- Obtaining funding for reintroduction projects can be challenging, so this must be anticipated and carefully planned.
- Government involvement is of utmost importance for establishing a network of inter-institutional collaboration through a Government-Science-Society framework.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- The spider monkeys underwent thorough veterinary assessments, including haematological and parasitological tests, several times during rehabilitation.
- Behavioural assessments in 2014, 2017 and 2023 - 2024 confirmed the monkeys exhibited species-appropriate behavioural patterns, including arboreal space use and alarm calls, consistent with the scientific literature (e.g., Lange & Robson, 2019).
- Habitat surveys confirmed the presence of spider monkeys' primary food sources in the release area.
- The monkeys were safely released with the support of organisations, volunteers, and the local community.
- Natural behaviours (e.g., feeding, resting) and group cohesion have been observed during the first several weeks of post-release monitoring.
- The project has provided work opportunities for the local community.
- The success of this initial reintroduction has paved the way for further reintroductions in the coming years and the establishment of a long-term population of spider monkeys in Nuevo Malzaga, Oaxaca, Mexico.

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Author Details

[1] Guillermina Jana Hernández-Cruz, Centro Mexicano de Rehabilitación de Primates (CMRP AC), Calle 5 de mayo 37, Axotla, Álvaro Obregón, Mexico City 01030, mvzguille@gmail.com*

[1] Centro Mexicano de Rehabilitación de Primates (CMRP AC), Ana María Santillán-Doherty, santild@gmail.com

[2] Conservación de la Biodiversidad del Usumacinta AC (COBIUS AC), Gilberto Pozo-Montuy, gmontuy@gmail.com

[1] Centro Mexicano de Rehabilitación de Primates (CMRP AC), Beatriz Alejandra González-Hernández, btrzalejandra@gmail.com

[2] Conservación de la Biodiversidad del Usumacinta AC (COBIUS AC), Braulio Pinacho-Guendulain, pinachogso@gmail.com



Reintroduction-based recovery of gaur in Bandhavgarh Tiger Reserve, Central India

Parag Nigam[1*], Ritesh Vishwakarma[1], Navaneethan, Balasubramanium[1], Nitin Gupta[2], Bilal Habib[1], Sankar Kalyansundaram[3], Himmat Singh Negi[2], Samrat Mondol[1], Subharanjan Sen[2], Jasbir Singh Chauhan[2], Aseem Shrivastav[2] & Priya Ranjan Sinha[4]

Introduction

Gaur (*Bos gaurus gaurus*) is the largest bovid of the oriental biogeographic region, distributed throughout south and south-east Asia and Sri Lanka in scattered pockets. Gaurs are predominantly grazers, and their diet consists mostly of grasses. The species plays an important role in maintaining terrestrial ecosystem by working as an ecological engineer by maintaining grassland ecosystems, ensuring seed dispersal and nutrient recycling, besides being an important prey species for large carnivores. The species has been listed as vulnerable (A2cd+3cd+4cd) in the IUCN Red Data list, as protected under Schedule I, Part I of the Indian Wildlife (Protection) Act (1972) and is placed under Appendix I of CITES.

The gaur populations remain threatened due to habitat reduction and fragmentation, resource competition with conspecifics and livestock, infectious diseases, and poaching (Duckworth et al., 2016). Recent past has witnessed local extirpation of gaur from Bandhavgarh Tiger Reserve (BTR), Sanjay Dubri Tiger Reserve and Kanger Valley National Park in Madhya Pradesh (in CIL) and from Thattekad Wildlife Sanctuary (Kerala) in the Western Ghats.

The BTR (1,536.7 km^2), located amongst the Vindhyan ranges and the eastern edges of Satpura hill ranges in the CIL, supported a small population of 35 - 38 individuals that became extinct around 1998, primarily attributed to the disruption of the migratory corridor. The reserve however, provided an excellent habitat for gaur. In order to restore the gaur population in BTR, a reintroduction based on the IUCN/SCC guidelines, a recovery programme was launched in 2011



Researchers selecting gaur for darting in the field atop Asian elephants

by the Madhya Pradesh Forest Department (MPFD) in partnership with the Wildlife Institute of India (WII) and &Beyond (previously CC Africa).

Main Goals

1. Monitor home range, dietary pattern, health status and herding dynamics of reintroduced gaur population in their new habitat.
2. Establish a self-sustaining and ecologically functional free-ranging population of gaur in BTR.
3. Evaluate breeding success and establish a viable population of gaur in BTR.
4. Restore the natural habitats through adaptive management for long term survival of gaur in BTR.
5. Develop a model reintroduced population based on scientific principles duly supported by the intensive monitoring of introduced and imminent generations.

Success Indicators

1. The Population of gaur has achieved the population intrinsic growth rate (r) ~0.099 per year, equivalent annual growth rate: ~9.9% per year in the last 14 years (2011 - 2024) and nearing the predicted carrying capacity of 180 - 200 individuals (Pabla et al., 2011).
2. The project has provided good understanding of the population dynamics with estimates of population size, home ranges, movement patterns, feeding preferences, reproductive performance including responses of reintroduced population to predator presence, disturbance, and environmental changes.
3. The natural home ranges of gaur in BTR have been established with expansion into other 'Gaur Suitable Habitats' of the reserve.
4. The initiative has resulted in development of cadre of sensitized and well-trained team that is capable of managing reintroduced populations.

Project Summary

Feasibility

The BTR provides a diverse habitat favourable for gaur. The availability of ample forest cover and water, especially in summer meets the ecological requirements for gaur. Based on the study by Pabla et al. (2011), a diversity of suitable habitats with food plant species are available in Bandhavgarh and found suitable to support the population of free-ranging wild gaurs. A plan was developed for reintroducing the gaur population from Kanha Tiger Reserve (KTR) based on Population Viability Analysis. The plan predicted a success probability of 1.0000 with a growth rate of 0.0459 in 100 years. The model simulated a scenario with

50 individuals having a sex ratio of 60% females and 40% males. KTR was chosen as it had a sizeable wild gaur population and similar habitat conditions to BTR.

Implementation

Fifty individuals (36 females and 14 males) from spatially different herds of individuals of various age classes and sexes were translocated using chemical immobilisation from KTR to BTR in two phases in 2011 and 2012. The first stock of 19 individuals was translocated in January 2011, and the second stock of thirty-one was relocated in March 2012 (Nigam et al., 2014). A total of 27 individuals were radio-collared to monitor their ranging patterns, habitat use, food habits and health conditions in BTR. Intensive monitoring of the reintroduced gaur population has been carried out for the last ten years. After 14 years (2011 - 2024), the reserve is home to around 181 individuals distributed over a substantial area of the park. Human resources, financial support and materials were provided by the MPFD, with WII as the technical partner.



Researchers working on darted gaur

1. *Preparatory phase*: Before the initial gaur release, the research team conducted independent surveys to select a healthy population. Training and workshops were provided to field staff and managers to develop necessary skills for reintroduction. A competent translocation team was identified to execute required procedures. A 50 ha predator-proof enclosure was constructed in BTR for the gaur's soft release.

2. *Field intervention*: All the animals were chemically immobilized using narcotics (Nigam et al., 2014) and translocated to BTR. A total of 27 (Two Telonics satellite/ GPS/VHF collars and 25 Telonics VHF) individuals were fitted with collars for intensive monitoring. A variety of tranquillizers, Azaperone, Haloperidol, and Perphenazine enanthate, were used to address possible stress related to capture and transportation and promote acclimatisation in a new environment.

Post-release Monitoring

During post-release monitoring, various ecological aspects, i.e. ranging patterns, home range stabilisation, herd formation, activity pattern, population structure, food habits and movement, were studied for 14 years after the reintroduction from 2011 - 2024. In the project's second phase, 6 individuals from unique herds were radio-collared in 2017. In the project's second phase, 6 individuals from unique herds were radio collared in 2017, for monitoring purposes. The monitoring was conducted based on a systematic on-field reporting mechanism and pre-designed survey protocols and necessarily followed from 06:00 - 18:00 hrs from both surveillance and scientific study perspectives.

Following the initial reintroduction and subsequent supplementation, the reintroduced gaur explored the park and formed four largely overlapping herds (Estimated annual inter-herd overlap 93.6% of 60 individuals by the end of 2012). By 2024, the population grew to 181 individuals, and the number of herds increased to seven, with annual inter-herd overlap significantly reduced to 0.5%. The herd sizes in BTR ranged from 6 to 31 individuals, and having mixed age classes. The overall estimated summer, monsoon and winter home ranges of gaur were 290 km^2, 137 km^2 and 155 km^2, respectively. The overall individual male home ranges varied from 135 - 142 km^2, and

overall individual female home ranges varied from 32 - 169 km^2 (Sankar et al., 2013).

Major Difficulties Faced

Biological

The gaur is a long ranging animal and hence the reintroduced population especially bulls moved and covered large distances and kept exploring their home ranges. Three individuals went missing during the course of the establishment phase during 2013 - 2015. Incidences of herds moving out of the park boundaries into human habitations was also a challenge. Although BTR is well connected with other reserves, but changing landscape dynamics emerged as a challenge and required landscape level planning and management.

With the expanding home ranges and the movement of animals outside of the park boundaries into human-dominated landscapes (agricultural lands), the chances of interactions with livestock, sharing of habitats and exposure to pathogens cannot be ruled out. Diseases have emerged as an important threat to the gaur population with a total of 18 deaths attributed to bovine tuberculosis (bTB) during the last 8 years. Additionally, FMD, haemorrhagic septicaemia and lumpy skin disease outbreaks have also been reported in livestock from the human-dominated landscapes surrounding the park, though these have not been reported in the gaur population.

Recently (since 2018), wild Asian elephants have colonised BTR from the adjacent state of Chhattisgarh, with the population showing an increasing trend. These are posing a challenge to the reintroduced gaur population due to the sharing of habitats and related resource competition (Nigam et al., 2020).

Broad Underlying Problems

None reported.



Gaur in natural habitat © Ritesh Vishwakarma

Major Lessons Learned

- The population has increased over the years with animals exploring new areas. Habitat restoration efforts need to be on the forefront with intensive efforts towards village relocation, habitat restoration and development of grasslands by the park management.
- Although three villages from BTR were successfully relocated, the reserve management needs to intensify the relocation efforts for the remaining (N=18) villages in the core area and support habitat recovery through effective grassland management.
- The reintroduced population requires the supplementation of the fresh gene pool to maintain genetic diversity to ensure a viable population.
- Diseases are becoming an important threat with cases of bovine tuberculosis surfing up in the population in the last 8 years. It necessarily calls for intensifying the health monitoring of the wild populations together with strategies to minimise interactions with livestock and study of disease dynamics in other conspecifics and sympatric livestock.
- Monitoring of gaur population is important and calls for efforts towards creating capacities of frontline staff and local communities in conservation and monitoring programmes.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- Gaur reintroduction in BTR is a successful conservation initiative of the mega-herbivore species in the country as the current population is growing in size. this demonstrates the effectiveness of long-term monitoring and management effort for a reintroduction programme.
- A comprehensive veterinary support has been developed in the state as well as in the BTR to support the efforts of reintroduction of mega-herbivores in BTR. A well-equipped team for capture, animal transportation, and monitoring was key to successful reintroduction.
- Multiple stakeholder collaborative approach was key to this successful conservation effort, where all the agencies involved contributed synergistically for achieving the project goals.
- Effectively regulated pre and post-project activities including initial feasibly studies, effective capture strategies, post-release monitoring and habitat management at BTR.

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Author Details

[1] Parag Nigam, Wildlife Institute of India, Chandrabani, Dehradun, P.O. Box No. 18, Uttarakhand 248001, India, nigamp@wii.gov.in*

[1] Wildlife Institute of India,
ritesh.mammals@gmail.com
navneeth.ooty@gmail.com
bh@wii.gov.in
smarat@wii.gov.in

[2] Madhya Pradesh Forest Department,
vetconitin21@gmail.com
chauhanjs87@gmail.com
himmatifs@gmail.com
subhoranjan.sen@gmail.com

[3] Former Director, Salim Ali Centre for Ornithology and Natural History,
ksankar62@gmail.com

[4] Former Director, Wildlife Institute of India & Country Representative, IUCN,
prsinha53@gmail.com



Conservation of the remnant population of Acacia gazelle in Israel

Tal Polak[1]* & Noam Leader[1]

Introduction

The Acacia gazelle (*Gazella acacia*) was discovered in the 1960s in southern Israel. Over the years, the population size fluctuated between 100 and 10 individuals. Genetic studies revealed that the species is related to the Arabian gazelle (*Gazella arabica*) (Endangered (EN)), with a subpopulation endemic to Israel (Hadas et al., 2015). Hence, the species' regional assessment is Critically Endangered (CR). In 2017, following the IUCN guidelines (IUCN, 2013), a strategic plan was developed (Maoz, 2017). The main objectives were to review the existing knowledge, identify the knowledge gaps, and quantify the actions needed for a successful reintroduction programmes. Today, the entire population, around 45 individuals, lives in a 350 ha fenced enclosure, protecting them from predation. Numerous resources and efforts ensure the species' continued survival, including biannual counts, calculating the enclosure's carrying capacity, food augmentation, and electric fence maintenance.

Main Goals

1. Increase the current population to 80 individuals.
2. Divide the population into two sub-breeding core populations in two separate enclosures.
3. Establish five stable reproductive wild populations to aid species conservation in different locations within the species' range.
4. Establish a monitoring system to evaluate the success of the reintroduction programme and the survival of the species.

Success Indicators

1. Achieving a breeding core population of 80 individuals.
2. Over 100 individuals in the wild at least 5 locations.
3. A positive growth rate of the population.



Monitoring gazelle in the field
© Golan Rider

Project Summary

Feasibility

The feasibility of reintroduction is one of the knowledge gaps identified (Maoz, 2017), and assessed with the aid of Population Viability Modelling. One major research project currently being investigated is the nutritional and habitat needs of the species, the identification of suitable release sites within the Arava Valley in southern Israel along the border with Jordan. The enclosure was constructed in 2006 around the last 12 individuals. In 2012, due to annual flooding, the fence collapsed, and the population crashed back to 12 individuals. Since then, the growth rate has been slow, indicating there may be underlying issues in the gazelles' breeding success.

Implementation

With the current growth rate, we believe we will achieve our first goal of 80 individuals within the next 5 years. Once we reach this goal, the population will be divided into two separate captive breeding populations. During this time, we expect to fill the knowledge gaps identified in the strategic plan, providing us with a clearer understanding of the next steps for the reintroduction plan, particularly regarding the establishment of wild populations.

Post-release Monitoring

The enclosure is 350 ha of open desert habitat with natural growth of acacia groves. The population behaves as wild-born. We have been monitoring the species within the enclosure since 2006, using bi-annual vehicle-based counts, trail cameras at waterholes and food sources, and weekly direct observations. Our understanding of the species' behaviour and our monitoring experience will assist us in constructing a monitoring system for the reintroduced populations.

Major Difficulties Faced

Biological

Ecological: Resource competition with another local gazelle species, the dorcas gazelle (*Gazella dorcas*), can affect the species' survival. Additionally, before the enclosure was built, predation was the major cause of mortality for the species.

Diet-related: Food shortages for young individuals may be a problem due to the increased grazing line caused by overgrazing within the enclosure.



Acacia gazelle in desert habitat
© Eran Gisis

Genetic: Since the population was discovered, it has undergone several severe bottlenecks, the last one in 2012. Low heterozygosity can cause problems; however, no current genetic issues are known, but potential risks exist.

Reproductive: Females have been known to become pregnant while still nursing a young fawn. This may reduce their ability to care for the existing offspring and reduce their fitness.

Broad Underlying Problems

- *Suboptimal habitat:* The enclosure is in a good habitat for the gazelle; however, the population increase of the dorcas gazelle in the enclosure has caused overgrazing of the acacia trees, which are the main food source for the Acacia gazelle. Additionally, the fence securing the enclosure is old with many gaps and needs to be replaced, but the cost is prohibitive at this time.
- *Climate change:* The hyper-arid desert habitat is expected to become more extreme, which can affect the Acacia trees within the enclosure and reduce the food supply.
- *Human-wildlife conflict:* None at the moment, but this may be a problem at the reintroduction stage of the programme.

Major Lessons Learned

- Our major lesson is that we have many knowledge gaps related to this species, although the population has been closely monitored for over 40 years. Addressing these knowledge gaps is crucial to understanding the feasibility of the species' reintroduction.
- The population of dorcas gazelle presents an additional complication both as a competitor and as a problem in population counts, as only experts can identify the difference between the two species.
- The breeding core population acts as free-range and is timid in the presence of people, making active care for the population nearly impossible. We are considering the pros and cons of domesticating the population to an open zoo population, which will help us improve their care and hopefully help increase the population growth rate.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

While we wait for the population to grow to our first goal of 80 individuals, we focus our efforts on closing our knowledge gaps and protecting the population from threats.

Reasons for Success/Failure

- Enclosing the remnant population within a fence was vital for the species' survival due to the increased predation risk.
- Identifying our knowledge gaps and conducting targeted research to address them allow us to understand the feasibility of the species' reintroduction and improve the programmes' success.

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Author Details

* *Tal Polak, Israeli Nature and Parks Authority, Jerusalem, Israel, talp@npa.org.il*

Noam Leader, leader@npa.org.il



Restoring the Visayan spotted deer to the island of Negros through reintroduction, Philippines

Matt Ward*, Justine Magbanua, Fernando Gutierrez, Monica Atienza & Ysabella Ward.

Introduction

The Visayan spotted deer (*Rusa alfredi*) (VSD) is an endangered species endemic to the West Visayan islands of the Philippines. Its historic range unfortunately has been dwindling, with populations remaining on only two islands, Panay and the focal island Negros. Because of this decline it is considered Critically Endangered in the Philippine Red List, and will be uplisted to Critically Endangered on the IUCN Red List in the near future. The release of this species has taken part in the Bayawan Nature Reserve in the Southwest Negros KBA, a region where the last viable population of the species also occurs along with other endemic biodiversity. This release was conducted as a result of a CPSG conservation planning workshop for the species, and followed the current Conservation Translocation guidelines with CTSG personnel kept in the loop of the project.

Main Goals

1. Establishment of a population of VSD into this extirpated area.
2. Promote breeding and population increase from the reintroduced population.
3. Study the natural history, ecology and behaviour of the VSD within the nature reserve, using camera traps and telemetry observations.

Success Indicators

1. Minimum 10% increase in released population through breeding after 2 years.
2. Maximum of 20% original population loss through mortalities within the first 2 years.
3. The species is accepted by local communities with surveys identifying the species as a non-resource and positive

feedback regarding the species introduction from at least 95% of people surveyed.

4. Observations of the reintroduced individuals shows acclimation to the reserve and secondary habitats. Their health is fair-good according to body condition scoring. Behaviour observation shows suitable natural foods being eaten and natural social behaviours observed.



Visayan spotted deer in the Bayawan Nature Reserve captured by a trail camera

Project Summary

Feasibility

The Bayawan Nature Reserve is a 300 ha area of secondary rainforest, grassland and open canopy forest. The deer's habitat preference is unknown, although its remaining populations are found within similar dense forest with grassland verges. The VSD does not hold much cultural significance, however one of the primary causes of decline has been poaching of young animals for the pet trade, with meat trade and casual hunting reducing adult numbers. This species has been extirpated from the release site, however the local community are excited to see it return, with older members recalling its presence 20 yrs prior.

Implementation

The initial cohort of 14 males and 14 females were released in June and August 2020 respectively, with a subsequent set of 2 males and 2 females released in November of that year. All individuals were selected from breeding groups within the Talarak Foundation captive conservation centres, according to their physical fitness/health (as checked by veterinary inspection) and their genetic lineage, with 13 genetic lines selected for the reintroduced population. All animals were put into soft-release enclosures within the reserve for 6 weeks prior to release, as they adapted to the social organisations and food available within the reserve.

Post-release Monitoring

Eight of the 32 initially released deer had GPS and VHF collars attached for monitoring. However, of these collars, only 4 worked effectively, and all but one deer removed the collars between a few months and a year. The primary method of monitoring is 25 remote camera traps, 5 units are set at artificial feeding stations (for behaviour and health observations) and 20 units at randomly selected locations across the 300 ha reserve. These cameras have already observed new born individuals, social interactions, injuries that heal, and natural behaviours.



Habitat in the Bayawan Nature Reserve

Broad Underlying Problems

- *Habitat loss and landscape changes:* Unfortunately much of the forested and natural grassland habitats that these deer require have been converted in agricultural plots for rice and sugar (in the lowlands) or coconut and agroforestry (in the uplands).
- *Poaching:* As with many species the VSD suffers from poaching threats. Adults are still hunted by locals for sport and food, but interestingly young animals are poached as exotic pets.
- *Population fragmentation:* As a result of the isolationism of viable habitats and populations, and the continued poaching threat of individuals that expand outward of dense forest, remaining populations are severely fragmented. Even if a local population was to persist, the viability of this population would be limited.

Major Difficulties Faced

Biological

The predominant biological difficulty with the release of this species, is the lack of knowledge on this species' ecology and natural history. Although this species has been kept in captivity for a long time, its wild ecology, diet and habitat preferences have never been recorded. This means we have had to learn almost all of this species' wild ecology from the released individuals.

Social

Due to the release date being in mid-2020, we were limited by Covid-19 restrictions around community gatherings and interactions. We had an outreach team involved in providing education and public engagement, however with local restrictions changing monthly according to covid this was erratic and our team were not able to reach the target audiences as fast or far as desired, nor hold group meetings.

Fortunately we were able to reach audiences up to 5 km away from the reserve within the first year of release, and the audiences were well received.

Major Lessons Learned

- The soft-release method of maintaining groups of males and females together for 6 weeks, may have helped to create hierarchies that established dominance before release. We had seen few occasions of aggressive encounters within the first 2 years, but more occasions of non-aggressive dominance displays or multi-male groups foraging together.
- The provision of supplemental food was influential in helping the released animals adjust to wild foraging and expanding ranges.
- Artificial feeding stations create a beneficial location for recording of social behaviour, individual health and seasonal changes in both.
- Camera traps were more successful in

monitoring animal health, behaviour, home range / movement, and other ecological interactions than telemetry. This is predominantly in part to the accessibility and feasibility for multiple cameras to be used over multiple telemetry collars, but also because the male deer frequently break the collars during combat.

- The adaptability of the species to the wild was fast and efficient, we encountered far less injuries or mortalities due to the terrain and habitat than were expected.
- Our outreach and education was vital in gaining acceptance from the community for the species. This was epitomised when a corn farmer contacted us to announce that an escaped individual was feeding on their corn plantation, but they were not upset and rather excited to see the species back in their community.
- The released individuals appear to have increased their fitness and size compared with the captive populations. Male deer having larger antlers than prior to release and both sexes' physical size appearing bigger, and injuries inflicted from fighting healing quickly with no residual effects.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- All main goals were reached.
- The reintroduced population is thriving, breeding steadily (~30 offspring in 3 years) and with minimal losses (4 losses in 3 years).
- The released animals and their new offspring are showing natural social behaviours (to the best of our knowledge) and feeding ecology.
- The communities in the surrounding area are accepting of the animals.

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Not available.

Author Details

[1] Matt Ward, Talarak Foundation Inc., Negros Forest Park, Bacolod City, Negros Occidental, Philippines 6100, talarakconservationteam@gmail.com*

[2] Justine Magbanua, Talarak Foundation Inc., jatenmagbanua@gmail.com

[3] Fernando Gutierrez, Talarak Foundation Inc., dinogutz@yahoo.com

[4] Monica Atienza DVM, Talarak Foundation Inc., monicamarie.atienza@gmail.com

[5] Ysabella Ward, Talarak Foundation Inc., ysabella.montano@gmail.com



Bolstering populations of the Visayan warty pig on the island of Negros through reintroduction into strategically significant sites, Phillipines

Matt Ward*, Justine Magbanua, Fernando Gutierrez, Monica Atienza & Ysabella Ward

Introduction

The Visayan warty pig (*Sus cebifrons*) (VWP) is listed as a critically endangered pig species, according to the Philippine Red List and IUCN Red List, and is endemic to the West Visayan Faunal Region of the Philippines. Unfortunately it is now restricted to the islands of Negros (study site) and Panay with populations dwindling. Although protected by national law, this species suffers greatly from habitat loss, human encroachment and direct persecution, with individuals being hunted for food but also persecuted to protect the agricultural crops which dominate the region. The reintroduction of this species was conducted in the Bayawan Nature Reserve in southwest Negros, after a conservation planning workshop with multiple experts identified reintroductions as a suitable method for population bolstering, and the reserve becoming an opportunity for ecological and human-animal conflict research to improve conservation outputs.

Main Goals

1. Establish a population of VWP into the Bayawan Nature Reserve.
2. Promote breeding and population increase from the reintroduced population.
3. Study the natural history, ecology and behaviour of the VWP within the nature reserve, using camera traps and telemetry observations.
4. Use the reintroduced population to identify suitable barriers between warty pigs and rural farmers (human-animal conflict study).



Visayan warty pig family in the Bayawan Nature Reserve

Success Indicators

1. Minimum 10% increase in released population through breeding after 2 years.
2. Maximum of 20% original population loss through mortalities within the first 2 years.
3. Observations of the reintroduced individuals shows acclimation to the reserve and secondary habitats, health is fair-good according to body condition scoring, and behaviour observation shows suitable natural foods being eaten and natural social behaviours observed.
4. Natural social structures are adopted by the released individuals as they reconnect with the wild.

Project Summary

Feasibility

The Bayawan Nature Reserve is a 300 ha area of secondary rainforest, interspersed grassland and open canopy forest. The deer's habitat preference is unknown, although its remaining populations are found within similar dense forest with grassland verges. The significance of the VWP is tragically focused around its use as a resource and pest. The species is highly intelligent and often finds a way to break into agricultural crops and cause significant damage when foraging. Additionally the Philippines has a long history of pork in the diet, and the VWP is often seen as a free meal.

Implementation

An initial cohort of 11 males and 11 females were released in June and August 2020 respectively. All individuals were selected from breeding groups within Talarak Foundation captive conservation centres, according to their physical fitness/health (as checked by veterinary inspection) and their genetic lineage, with 13 genetic lines selected for the reintroduced population.

All animals were put into soft-release enclosures within the reserve for 6 weeks prior to release, as they adapted to the social organisations and food available within the reserve. To support the individuals, six feeding stations were established to supplement food for the first 2 years.



Placement of camera traps in the Bayawan Nature Reserve

Post-release Monitoring

VHF and GPS collars were initially used to track individuals for behaviour and monitoring but unfortunately the animals were smart enough to remove the collars on their own. Although one male pig did retain his collar, his behaviour and well-being was severely affected. He began losing weight and was a recipient of aggression by the other individuals, this led us to remove his collar and his health gradually returned. We have now switched to using camera traps for behavioural monitoring as we found this to be the most successful means of studying and observing the species after release.

Major Difficulties Faced

Biological

Despite being found in several sites across its range, there is limited knowledge on this species' population status (and population spread), natural behaviour and ecology. The released stock came from several generations of captive bred individuals. Despite having maintained distinct genetic lines and good husbandry practices we still had no idea how the species would fare in the wild setting.

Operational

Since all the work we are currently doing is a first for the species, we are currently learning new things all the time. One difficulty we have encountered is what telemetry device would be suitable for monitoring the pigs. During the pre release stage we settled with

using radio and GPS collars to track the movement of the animals throughout the reserve. We quickly learned that the pigs were smart enough to take off the collars and the one pig whose collar stayed on suffered from negative interactions with other individuals and his body condition deteriorated to the point where we had to remove the collar after which he promptly recovered and started to gain weight.

Social

It is widely known among rural communities that pigs are pests towards crops. One of the major causes for human-wildlife conflict between the Visayan warty pigs and farmers is due to crop raiding by warty pigs. We planned to mitigate these issues by having our outreach team go to the surrounding communities and explaining to the locals what our work is about, how we can help them, how they can help us and how they can benefit from this project.

Broad Underlying Problems

- *Suboptimal habitat:* Habitat loss continues within the species range as human encroachment into forests and natural land. Agriculture is the main driver for habitat loss and fragmentation and does not look to cease soon.
- *Human-animal conflict:* As agricultural lands continue to expand into forest areas, human-animal conflict continues to increase as the pigs break into farmlands and raid crops. This prompts farmers to take measures to protect their crops mostly using invasive and deadly measures to prevent pigs from eating the crops, including hunting groups of pigs as preventative measures.
- *Interaction with domestic species:* In most rural areas, domestic pigs are often kept in outdoor areas and not inside pig pens. This often results in wild pigs visiting the domestic pigs and breeding with them. This presents the opportunity for disease transfer between the animals, results in hybrids which could spread in the wild, and poses significant danger to wild pig populations with the outbreak of ASF in the country.

Major Lessons Learned

- Education and outreach activities by reserve staff has learned that hunting of Warty Pigs is usually initiated by people who are not from the community. The locals are more often than not used as guides by the hunters to locate the pigs within the area. Additionally those members of local communities who admit to hunting pigs do so for crop protection rather than for food or other purposes.
- Camera traps as a method to monitor warty pig behaviour and status within the reserve was quite effective as the species tend to be very cryptic and wary of human presence. However there is a difficulty using camera traps as individual identification is almost impossible and so measuring home ranges, space use and individual interactions are hard.
- The species seems to be very adaptable to different habitats. Having them adapt to the area by placing them inside the soft release enclosures for a certain period of time may have helped them acclimate to the new location.
- Given opportunity to explore natural habitats and recuperate natural behaviours, the pigs appeared to settle very quickly into the reserve, improve health and natural social behaviours, and thrive in a short period of time.
- The outreach that our education team have been conducting seems to have left an impact to the community since they have notified us immediately if one of our animals has escaped from the reserve.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reason For Success/Failure

- Proposed goals of the study were reached.

- Animals were able to adapt to being in the wild and they were able to reproduce quickly, doubling in number in around 2 years.
- Offspring and released individuals are showing natural behaviour.
- Dynamic social structures were seen through camera trap footage involving different sex groups and hierarchy between them.
- Deterrent studies are being conducted to try and develop solutions to the human-animal conflict concern.
- Natural foraging behaviours are observed and pigs are seen eating and foraging naturally.

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Not available.

Author Details

[1] Matt Ward, Talarak Foundation Inc., Negros Forest Park, Bacolod City, Negros Occidental, Philippines 6100, talarakconservationteam@gmail.com*

[2] Justine Magbanua, Talarak Foundation Inc., jatenmagbanua@gmail.com

[3] Fernando Gutierrez, Talarak Foundation Inc., dinogutz@yahoo.com

[4] Monica Atienza DVM, Talarak Foundation Inc., monicamarie.atienza@gmail.com

[5] Ysabella Ward, Talarak Foundation Inc., ysabella.montano@gmail.com



Forty years of Arabian oryx reintroduction in Israel

Tal Polak* & Noam Leader

Introduction

The Arabian oryx (*Oryx leucoryx*) historically roamed much of the Arabian Peninsula. In modern-day Israel, the last oryx were extirpated by the late 19th century, and by 1972, the species was extinct in the wild. Thanks to intensive reintroduction efforts, the Arabian oryx is now classified as Vulnerable. The reintroduction programme in Israel began in 1978 with the arrival of eight Arabian oryx at Hai-Bar Yotvata. Between 1997 and 2007, 111 individuals were reintroduced through eight soft release events at three suitable desert locations in southern Israel.

In 2017, following IUCN guidelines, a strategic plan was implemented, restarting the programme with a series of hard releases at three sites with known oryx activity.

Main Goals

1. Establish a stable, reproductive wild population to aid species conservation.
2. Restore ecosystem functions lost with the species' extirpation, particularly as the primary dispersal agent for acacia trees (Polak et al., 2014).
3. Augment the population starting from 2017 to increase the wild population formed in the first phase.
4. Integrate released individuals with GPS collars into existing herds to study movement patterns and habitat use.
5. Develop advanced population monitoring tools, including genetic analysis and AI-driven aerial photograph analysis.

Success Indicators

1. Over 100 individuals in the wild.
2. A positive growth rate.
3. First-month survival of hard release individuals.
4. Successful integration of hard release

individuals into local herds.

Project Summary

Feasibility

The feasibility of the original programme was outlined in the 2008 Global Reintroduction Perspectives. A stable, reproductive wild population is crucial for success. However, since the programme's inception, no long-term post-release monitoring has been conducted. Knowledge gaps about the wild population hinder decision-making.

In 2017, the reintroduction programme was reassessed, and a new strategic plan was formulated (Shalev et al., 2017) following IUCN guidelines (IUCN, 2013). The plan covers reintroduction, monitoring, and captive breeding core management. It recommended annual releases of 6 - 9 individuals to reach a goal of 100 individuals in the wild and reducing the breeding core to 80 individuals. Several pilot monitoring programmes were also suggested.

Implementation

The breeding core, originating from eight individuals in 1978, now numbers around 120. The strategic plan aims to reduce this to 80.

The hard released programme continues with 6 - 9 individuals release annually, ensuring at least 50% females and 50% with GPS tracking.

The release programme will continue until genetic testing confirms a stable wild population of at least 100 individuals.

Post-release Monitoring

Currently, there is no established monitoring programme. Previous methods (aerial counts, waterhole counts, camera trapping) were unsuccessful due to habitat scale and the oryx's timid nature.

We are testing two promising techniques: genetic analysis from field-collected pellets and AI identification of oryx in annual aerial orthophotos.



Releasing Arabian oryx into the wild
© Ela Agra

Major Difficulties Faced

Biological

Ecological: Predation by grey wolves.

Anthropogenic: Disturbances from military training areas.

Genetic: Low heterozygosity due to a small founding population but potential risks exist.

Behavioural: The oryx's skittish nature and wide-ranging behaviour complicates monitoring.



Overview of Arabian oryx release site
© Golan Rider

Broad Underlying Problems

- *Suboptimal habitat:* Some areas affected by anthropogenic disturbance.
- *Climate change:* Hyper-arid desert habitat expected to become more extreme.
- *Human-wildlife conflict:* There are two main Anthropogenic threats:
  - Wildlife-vehicle collisions.
  - Hunting across borders, there are seven documented cases of oryx with GPS trackers which were hunted almost immediately, after crossing.

Major Lessons Learned

- The original reintroduction events from 1997 - 2007 seem to have established a viable population. However, without an effective monitoring method in place we had no evidence to support this claim.
- Ten years after the last release event, we decided to reassess the reintroduction programme, drafting the stages needed to finalize the reintroduction programme.
- The hard release method is effective, with a 62% first-month survival rate and 53% integration into wild herds.
- Advance genetic and AI technologies may provide robust monitoring solutions for this allusive species
- Post-reintroduction breeding core management requires ongoing adjustments and resources.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure
■			

We consider the Israeli Arabian oryx reintroduction programme Highly Successful. Evidence indicates we have surpassed our initial goal of 100 individuals, with orthophoto analysis identifying individuals in 20% of the species' main habitat.
While growth rate monitoring is lacking, field observations show viable, wild-born herds. Recently hard-released individuals reproducing in the wild. Oryx plays a crucial role in dispersing Acacia seeds, enhancing their germination success (Polak et al.,

2014).
The hard-release method was found to be a robust method allowing flexibility in release sites and improving the chances of released individuals to integrate into wild herds.
GPS-tagged individuals have improved habitat mapping.
Lastly, technological advancements are helping to develop effective monitoring techniques.

Reasons for Success/Failure

- Since the establishment of the state of Israel the hunting of most species, including large ungulates became illegal. The Israeli Nature and Park Authority enforce this practice rigorously. Since hunting was the main cause of the species extinction from the region, the removal of hunting as a treat was the main reason of the programme success.
- Suitable release sites with abundance of Acacia trees and other suitable edible desert plants was key for the establishment of the first large populations of oryx.
- Selecting young adolescents individuals (2 - 3 years old) for hard release improved their integration into local herds.

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Author Details

* *Tal Polak, Israeli Nature and Parks Authority, Jerusalem, Israel, talp@npa.org.il*

Noam Leader, leader@npa.org.il



Reintroduction of the black rhinoceros to Gonarezhou National Park in Zimbabwe

Simon Capon[1], Bob Mandinyenya[2] & Kevin M. Dunham[3]*

Introduction

The south-eastern black rhinoceros (*Diceros bicornis minor*) is IUCN listed as Critically Endangered, because of commercial poaching for its horns. It is on CITES Appendix I. Gonarezhou National Park (GNP) covers ~5,000 km^2 in south-eastern Zimbabwe, adjacent to the international border with Mozambique (Dunham, 2012). The original black rhino population was eliminated during the 1930s or 1940s, likely by overhunting. The species was reintroduced successfully during 1969 - 1971 and the population increased to ~100 individuals by 1982, but the reintroduced population was eliminated by poaching during the 1980s and early 1990s, at least some of which was likely by park staff. The recent reintroduction was guided by the IUCN Guidelines for Reintroductions and other Conservation Translocations (IUCN, 2013) and the IUCN Guidelines for the in situ Re-introduction and Translocation of African and Asian Rhinoceros (IUCN, 2009) (Dunham & Robertson, 2020).

Main Goals

1. Establishment of fenced Intensive Protection Zone (IPZ).
2. Recruitment and training of 39 additional rangers for law enforcement.
3. Release of at least 20 unrelated black rhino founders into IPZ.
4. Increase in rhino population number in GNP to >100 animals, so that the Gonarezhou black rhino population is classified as a 'Key 1 population'.

Success Indicators

1. Zero or low mortality amongst released individuals.
2. Zero or low mortality due to poaching amongst all individuals.
3. Successful breeding by released individuals.

4. Successful breeding by wild-born individuals.

5. In the longer term, an average net rate of population increase of ≥5% per annum and a population number >100 rhinos.



Black rhino in Gonarezhou with monitoring team © Gonarezhou Conservation Trust

Project Summary

Feasibility

GNP is within the Greater Limpopo Transfrontier Park. It experiences low (mean ~490 mm) and variable (CV 29%) annual rainfall. Major vegetation types are: *Colophospermum mopane* shrubland or woodland; *Guibourtia conjugata* dominated woodland; mixed woodland on granophyre; and riverine woodland. GNP supports a variety of large herbivores and predators, including >2 elephants/km^2. The black rhino is nocturnal and often solitary, with poor eyesight, acute hearing and a keen sense of smell.

Reintroduction planning advanced after an agreement with local people illegally settled in the park permitted their continued occupation, but an electrified fence separated them from the remainder of GNP.

Implementation

Twenty nine wild-living rhinos (8 adult females, 3 subadult females, 5 adult males, 5 subadult males, 5 female and 3 male calves) were translocated during May - August 2021 and released at two sites, one north of the Runde River and one south. The rhinos came from Bubye Valley Conservancy, Malilangwe Wildlife Reserve and Save Valley Conservancy. Each adult female was accompanied by a calf >16 months of age. The rhinos were immobilised by an experienced veterinarian from a helicopter and loaded into individual crates for transport by truck to GNP. After ~10 days in pre-release pens, they were freed into the ~500 km^2 IPZ.

Post-release Monitoring

While immobilised, each adult and subadult was fitted with a horn-implanted VHF transmitter. Each rhino was given an individual pattern of ear notches to permit later recognition.

After release, each rhino was located regularly during the daytime with VHF radio-telemetry, by a ranger patrol or from the air (Wielgus et al., 2023); or by ground-tracking.

By the end of 2023, 2 released calves (1 male, 1 female) had died soon after weaning, 12 and 15 months after release. Seven calves (2 conceived in GNP) had been born. The first-born calf disappeared and is assumed to have been killed by a predator.

Major Difficulties Faced

Biological

Behavioural: Two rhinos released as calves died soon after weaning. At this time, a calf is chased away by its mother, as the birth of

her next calf approaches. A recently weaned calf, newly solitary, is vulnerable to attack by predators and adult male rhinos. It will often seek the company of another recently weaned calf, although after 3 - 8 months, its mother may allow it to rejoin her (Emslie & Adcock, 2013). When the calves were immobilised for translocation to GNP, their horns were too small to permit a VHF horn-implant transmitter to be fitted. Hence, once a translocated calf was weaned and left the company of its mother, monitoring its wellbeing and survival became more difficult.

A significant delay in finding the skeletal remains of one of the weaned calves that died prevented determination of the cause of its death. The other weaned calf was found limping badly - it was recaptured and placed in a boma for treatment, but died nonetheless. It had suffered a mid-shaft fracture of the right fibula which led to a shearing, rotation, and tilting fracture through the proximal growth plate of the right tibia. It is probable that this rhino was injured during a confrontation, either with an adult rhino, or with an elephant.

Following the two deaths, two surviving calves with sufficiently large horns were each fitted with a horn-implant transmitter. Monitoring of three surviving weaned calves without transmitters remained difficult once they left their mothers, although sometimes they were found with another rhino that was fitted with a transmitter. One released calf is still with its mother, who has not given birth since her release.

Broad Underlying Problems

- *Range expansion within GNP:* The IPZ fence limits dispersal by the rhinos, which permits more efficient allocation of law enforcement efforts. But even after the IPZ was expanded to ~586 km^2 at the end of 2022, it is not large enough to accommodate >100 rhinos and there remains a need to increase the area available to rhinos within GNP if the rhino population is to reach Key 1 status. The long-term goal of a population of >100 rhinos can be achieved only by allowing the rhinos to range over most of GNP. But removal of the IPZ fence without an alternative fence (e.g. along the eastern park boundary which is also the international border) would permit rhinos to move into an area of Mozambique where there has been significant anthropogenic mortality of elephants during recent years. Efforts to address this cross-border issue are underway.
- *Founder number:* Pedigree analysis by Zimbabwe's Lowveld Rhino Trust reveals that the surviving released rhinos represent 19 unrelated founders, not the minimum of 20 recommended by the IUCN guidelines for rhino reintroductions.
- *Finance:* The density of rangers required to provide security for rhinos is expensive to maintain. An individual rhino has a potential lifespan of ~40 years. Hence, protecting a rhino population from poaching requires major funding for decades ahead.
- *Competition with elephants for food:* Research in the IPZ since the rhino releases has shown that there is substantial overlap between rhinos and elephants in feeding areas, the plant species selected and foraging height, although elephants utilise stems of greater diameter than rhinos. Efforts have been made to lessen competition by driving elephants out of the IPZ and thus reducing the elephant density there.

Major Lessons Learned

- *Long period of preparation:* Frankfurt Zoological Society (FZS) provided technical and financial support towards the management of GNP for a decade before the founding, during 2017, of Gonarezhou Conservation Trust (GCT), a co-management partnership between Zimbabwe's Parks & Wildlife Management Authority and FZS. The 13 years between the start of NGO assistance to park management and the reintroduction permitted the establishment of GCT in parallel with a thorough revision of management practices, the retraining of existing management staff and the recruitment and training of new staff.



Gonarezhou intensive protection zone with electrified fence © Kevin Dunham

- *Custodians of source populations as partners:* The custodians of the source populations of black rhino were willing partners in the reintroduction. The sex and age ratios of the animals selected for translocation were the ratios regarded as optimum for the reintroduction.
- *Selection of founders:* The Bubye and Malilangwe source populations are especially well monitored and the monitors' knowledge of the individual rhinos before translocation contributed to the smoothness in which the rhinos settled into their new environment.
- *Neighbours as founders:* In each source population, the individuals selected for translocation were known to each other and it was intended that the stress of the translocation would be reduced if, after release, individuals found themselves in the proximity of other rhinos with whom they were already familiar.
- *Fenced IPZ:* The fence around the IPZ limited the range of the rhino population, which allowed ranger patrols to be deployed to maximum effect, and prevented the dispersal of rhinos across the international border into Mozambique.
- I*PZ fence also an elephant fence:* Although the IPZ fence is relatively flimsy, it is electrified and intended to limit the movement of elephants as well as rhinos, in the hope that this will reduce competition for food between rhino and elephant inside the IPZ. But even if there is no movement of elephants into the IPZ, the number of elephants already inside will, in the absence of management, increase with births (with an expected population doubling time of ~15 years).
- After the deaths of 2 weaned calves, a transmitter was implanted in the horn of two of the remaining large calves (the only two that had a horn large enough to accommodate a VHF transmitter) in order to facilitate monitoring when they left their mothers.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- A long-preparation time between the start of NGO assistance to park management and the reintroduction.
- Use of this period to revise park management practices and to recruit and train new staff.
- Delaying the reintroduction until after relations between the local community and the park had improved significantly. Once reintroduction planning started, there was early engagement with local communities, including field trips to see the reintroduction process, and

communities named the individual rhinos, thereby creating a sense of ownership.

- Partners at the source populations facilitated ranger exchange visits before rhinos were translocated to allow GCT rangers to gain experience of tracking, approaching and monitoring rhinos.
- It is too soon to determine if rhinos born in GNP will breed successfully (because of the years that it will take for these rhinos to reach maturity), or to determine the medium-term average net rate of population increase. The reintroduction can best be judged as 'So far, so good'.

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Author Details

[1] Simon Capon, Gonarezhou Conservation Trust, simon@gonarezhou.org

[1] Bob Mandinyenya, Gonarezhou Conservation Trust, bob@gonarezhou.org

[1] Kevin M. Dunham, PO Box CH385, Chisipite, Harare, Zimbabwe, kmdunham@protonmail.com*



Reintroduction of milu into the Daqingshan Mountain, Inner Mongolia, China

Cheng Zhibin[1,2], Li Mingzhe[3], Ma Haibo[4], Su Ritu[4], Ju Hua[4], Zhong Zhenyu[2], He Lun[3], Duan Jianbin[2], Hao Rentaben[4], Guo Qingyun[2], Wang Libo[5], Xie Shengbin[5], Cheng Kun[1]* & Bai Jiade[2]**

Introduction

Milu (Père David's deer, *Elaphurus davidianus*), is endemic to China. Their main habitat is wetlands, and were widely distributed in the the warm and humid plain marshlands of the Yangzi River basin and Yellow River basin in China (Cao et al, 1990; Bai, 2020). Due to climate change and expanding human activities, milu became extinct in the wild. Floods and wars subsequently caused the extinction of the last captive population in China around 1900 (Jones, 1951). Milu is listed on the IUCN Red List as EW. From 1985 to 1987, 79 milu were reintroduced to China from England, establishing the milu population in China (Thouless et al, 1988). After over 30 years of conservation efforts, the milu population has expanded to 9,062 individuals in 2021 (Cheng et al, 2021). The Milu Reintroduction Project in Daqingshan Mountain aims to strengthen existing conservation outcomes and establish additional self-sustaining wild populations. Since the project's launch in 2019, 27 milu individuals have been released into Daqingshan Mountain, with the current population growing to 64 individuals.

Goals

1. Reintroducing a population of milu in the Inner Mongolia Daqingshan Mountain National Nature Reserve for conducting adaptive research.
2. Raise awareness of milu and biodiversity conservation for local and national residents through media campaigns.
3. Release them to the wild in Inner Mongolia Daqingshan Mountain National Nature Reserve when they have adapted to the local habitat and climate.
4. The milu population in Inner Mongolia

Daqingshan Mountain National Nature Reserve steadily increases each year.

5. The released population of milu adapted to the wild, found their suitable habitat, and successfully reproduced.



Feasibility Study in Daqingshan Mountain

Success Indicators

1. Successfully reintroduced 27 (9 males; 18 females) individuals into Inner Mongolia Daqingshan Mountain National Nature Reserve in 2021.

2. A population growth rate of 10% or above per year.

3. Reintroduced the fenced population of 35 individuals to the wild in Inner Mongolia Daqingshan Mountain National Nature Reserve in 2022.

4. The released population found their adaptive habitat and reproduced well.

5. The first year after release into the wild, the calves survived in the harsh winter conditions in the wild. After release, new calves were successfully born every year, with a population growth rate of 10% or above per year.

Project Summary

Feasibility

In 2019, the State Forestry and Grassland Administration commissioned the China Wildlife Conservation Association to initiate and implement the reintroduction project for milu. Starting from December 2019, a project survey team composed of researchers from the China Wildlife Conservation Association, Inner Mongolia Forestry and Grassland Administration, Beijing Milu Ecological Research Center, Dafeng Milu Nature Reserve in Jiangsu, and Daqingshan Mountain Nature Reserve in Inner Mongolia conducted multiple inspections and surveys to select a suitable location for milu rewilding training. Feasibility studies included edible plants, hydrology, temperature, topography, and other factors.

The Baishitou Gou Management Station (E111.4533°, N40.8029°) of Daqingshan Mountain Nature Reserve, with a total area of 15,102 ha, was chosen as the site for the milu rewilding training. This area is a major natural secondary forest area in western Inner Mongolia, characterised by forest land, shrub forest land, and grassland, with a forest coverage rate of 47.8%. The average annual temperature ranges from 7.5 - 7.6°C, with a maximum temperature of 35°C and a minimum temperature of -25°C. Humidity ranges from 100 - 200% relative humidity on rainy days to 10 - 20% on sunny days throughout the year. The annual precipitation is 383 mm. And there is a reservoir and several natural springs, providing environmental conditions suitable for various



Milu reintroduced to Daqingshan Mountain, Inner Mongolian, China

flora and fauna, particularly conducive to milu habitat.

Implementation

In June 2021, at the Baishitou Gou Management Station, an area of over 243 ha for semi-free-ranging enclosure was established. On 27th September 2021, 22 individuals (4 males, 11 females and 7 juveniles) from Beijing Milu Park and 5 individuals (2 males and 3 females) from Jiangsu Dafeng Milu Nature Reserve were transported to Daqingshan Mountain. They were initially placed in a 400 m^2 enclosure for short-term acclimation. They were released into the wild at Daqingshan Mountain on 29th September 2021, marking the beginning of their rewilding training.

The milu quickly adapted, though one female died after release due to transport syndrome. During autumn, they roamed freely, enjoying abundant vegetation. In winter, after over 2 months of grazing, food availability dropped, so from November 2020 - May 2021, staff supplemented their diet with carrots, concentrated feed, and alfalfa. On 2nd February 2022, the first milu calf was born.

To enhance public awareness of milu conservation, extensive media coverage by national and local mainstream media outlets including television and newspapers was conducted during events such as reintroduction activities, births period, wildlife conservation awareness month, and International Biodiversity Day.

Post-release Monitoring

On 8th June 2022, the rewilding milu were released, with only the northern fence opened due to proximity to Hohhot City. Two monitors patrol daily, while the research team tracks feaces, water, soil, and vegetation.

Daqingshan Mountain Nature Reserve, established in 2000, ensures no human interference for milu rewilding. The steep southern slope with canyons influences milu movement, mainly within north-south canyons, and they climb slopes under 60° based on vegetation and food availability.

After release, during this period, an adult male milu fell to its death while climbing, an adult female died from diarrhoea, and a sub-adult female died from maggots in the genital area. On 17th April 2023, the first wild milu calf was born and currently, the population is 64 individuals, totally 41 calves, with an annual population growth rate of 14.3 - 14.6%. GPS collars were initially placed on 15 milu, but only two are still transmitting signals. Milu activity now spans five branching canyons. From October to May, daily feed, including carrots and alfalfa, is provided, with amounts decreasing from 2021 - 2024. Wild milu mainly range within 4 km of the release site, extending up to 7 km.

Major Difficulties Faced

Biological

Ecological: The population of milu grows rapidly, with a current growth rate of over 10% per year. Resources are limited in the narrow canyon areas, leading to increasing environmental pressure year by year.

Ecological: With the rapid increase in population, there are risks of epidemics such as hemorrhagic enteritis.

Ecological: When the released milu population increases significantly, there is a risk of exceeding the local carrying capacity due to the absence of natural predators. Effective measures may be needed in the future to control population growth.

Ecological: When the released milu population increases significantly, there is a risk of exceeding the local carrying capacity due to the absence of natural predators. Effective measures may be needed in the future to control population growth.

Environmental: The release site of milu is located on the southern slope of Daqingshan Mountain, with steep terrain, making it difficult for Milu to spread to the flat and vast northern slopes. They can only live in canyons and areas with gentler slopes.

Environmental: Some canyons lack water sources, limiting milu dispersal.

Climate: Due to food scarcity in winter, artificial feeding is necessary, and the released milu are not completely independent of humans.

Economic: There is a lack of funding for monitoring and research. Out of the 15 GPS collars worn, only two currently have signal transmission.

Major Lessons Learned

- Government support and project funding are crucial for the successful execution of this release project.
- Expanding new release sites is of significant importance for the conservation of endangered species.
- The success of reintroduction is closely correlated with the size of the population reintroduced. As large herbivores, larger reintroduced populations generally have higher success rates.
- Promoting population connectivity and fusion between geographically isolated populations through human intervention is crucial for enhancing species genetic diversity.
- Conserving endangered species requires the participation of multiple departments, various industries, and more people.
- Natural reserves with minimal or no human disturbance are of significant importance for species reintroduction projects.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reason for Success/Failure

- Implement stage wild-release plans.
- In the first stage, in semi-free term, the milu had successfully adapted to the local climate and environment, smoothly passing through their first harsh winter and reproducing successfully.
- In the second stage, in the wild, both adult individuals and newborn calves had successfully survived in the harsh winter, finding suitable habitats; they were able to mate and reproduce freely and successfully.
- The project was supported by government and news media for a long time.
- There was a dedicated project execution team that comprehensively and attentively protected the released milu.
- Close cooperation between a research

institution and a nature reserve, with long-term attention and continuous monitoring and tracking.

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Author Details

[1] College of Wildlife and Protected Areas, Northeast Forestry University, Harbin 150040, China,*
chengkcn@163.com
miluchengzb@163.com
[2] Beijing Beijing Milu Ecological Research Center, China, baijiade234@aliyun.com
[3] China Wildlife Conservation Association, China.
[4] Inner Mongolia Daqingshan National Nature, Reserve Management Bureau, China.
[5] Jiangsu Dafeng Milu National Nature Reserve Management Bureau, China.



Factors critical to successful mangrove restoration: a case study from Abu Dhabi, UAE

Himansu S Das*, Amna Al Mansoori & Nessrine AlZahlawi

Introduction

Mangroves have been lost and degraded for decades for coastal development, urbanisation, land-use change and pollution lessening the services they provide (Leal & Spalding, 2024). However, rates of loss have declined over the past decades due to improved awareness and implementation of policies for conservation and restoration. One species of mangrove the grey mangrove (*Avicennia marina*) occurs in Abu Dhabi, United Arab Emirates (UAE) in the Western Indian Ocean Region. These mangrove stands covers an area of 176 km^2 and are considered a critical coastal ecosystem. Mangroves as an ecosystem is classified as Endangered regionally and nationally according to IUCN Red list of ecosystems (Javed et al., 2022). In this paper, we discuss the success of a restoration programme that was undertaken from 2013 - 2015 following international best practices (EAD, 2024) and based on scientific criteria.

Main Goals

1. To assess success of mangrove restoration programmes.
2. To identify scientific criteria for a successful restoration of mangroves.
3. To determine critical indicators of success.

Success Indicators

1. *Morphology:* Height of the plant (>2.5 m) with healthy branches and pneumatophores.
2. Flowering, fruiting and natural regeneration.
3. Presence of benthic organisms such as gastropods and crabs within the restored sites.
4. Soil analysis shows carbon sequestration.

Project Summary

Feasibility

Mangrove restoration in Abu Dhabi in the form of plantations within and around the sparse natural mangroves started as early as 1970. The programme continued for over 30 years with small-scale plantations with almost no standard monitoring. In 2010, large scale plantations started to restore lost and degraded mangrove areas as compensation to coastal development projects.



Healthy restored mangrove area post-10 years

Implementation

In 2013, 2 million nursery raised saplings (30 cm height with 3 - 5 pairs of leaves) were planted in 3 sites of Jubail island (N24.516428°, E54.477174°) (Jubail SW, Jubail NW and Jubail NE). Planting was carried out during post winter (March to May) and post summer (October to December) months to avoid unsuitable marine water quality, mostly high and low water temperature) and strong waves due to rough weather. At least 30 trained workers planted 3,000 - 4,000 saplings per day for 600 days between 2013 and 2015.

Post-planting Monitoring

The planting was completed in 2015. We monitored the restoration sites every 6 months after planting (6, 12, 18 and 24 months) for 2 years. On a few occasions, dead and sick saplings were replaced with healthy saplings. Monitoring was critical to measure success of the programme hence sites were visited after 5 and 10 years (2020 and 2025) to collect data on indicators of a naturalised mangrove habitat.

Major Difficulties Faced

Biological

Restoration site 3 was grazed by gazelles.

Sea surface temperature below 20° C and above 26° C affects growth of mangrove saplings.

Adverse marine water quality and sedimentation

Operational

Inaccessible plantation areas caused delay in implementation with an increased cost due to unconventional and varied transport.

Broad Underlying Problems

None reported.



Mangrove team during field monitoring

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Sites 1 and 2: There is a good overall growth (height >3m, flowering/fruiting and natural regeneration); benthic organisms have colonised the site; the population/patch has started providing ecosystem services including carbon sequestration.

Site 3: There are grazing and hydrological changes including sedimentation and there is relatively poor growth with no regeneration.

Reasons for Success/Failure

- Selection of appropriate sites.
- Ideal sediment chemistry.
- Tidal inundation (timely and natural).
- Saplings to be healthy (>30cm length and 3 - 5 pairs healthy leaves).
- Community participation in mangrove. restoration is critical to spread awareness and minimizing cost.
- Use of technology is important to make large scale restoration cost effective and successful.

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Author Details

* *Expert, Marine Biodiversity Assessment and Conservation, Terrestrial and Marine Biodiversity, Environment Agency Abu Dhabi, UAE, hsdas@ead.gov.ae*

Environment Agency Abu Dhabi, UAE, Amna.Almansoori@ead.gov.ae

Environment Agency Abu Dhabi, UAE, Nessrine.Alzahlawi@ead.gov.ae



Population reinforcement of white saxaul within protected areas in Abu Dhabi, United Arab Emirates

Sabitha Sakkir * & Jamal Al Zaidaneen

Introduction

The white saxaul (*Haloxylon persicum*) is a species of biogeographical importance, in the United Arab Emirates (UAE), with a restricted distribution. While the species is classified as Least Concern on a global scale on the IUCN Red List, regionally and nationally, the species is assessed as Endangered according to IUCN Red list of species (Javed et al., 2020). This status highlights the critical need for conservation efforts to protect this species from further decline. In the UAE, the species faces threats from habitat loss, overgrazing, and climate change. The species is crucial to the local ecosystem, holds significant cultural values and provide habitat and food for various wildlife. Conservation strategies, including in situ and ex situ conservation, habitat monitoring and legal protection are in place to ensure the protection of this important species.

Several steps have been taken by the Environment Agency-Abu Dhabi (EAD) to conserve the species. In the UAE, this species is found only in Abu Dhabi Emirate, and these areas have already been designated as protected areas. Due to the lack of natural regeneration in the wild, population reinforcement strategies have been implemented to boost the existing population.

This initiative has been successfully executed at Al Wathba Wetland Reserve (AWWR) which is a natural habitat for the species. AWWR is located at 40 km southeast of Abu Dhabi Island and covers an area of 5 km^2. This is the first protected area in Abu Dhabi emirate, to be declared as ‘wetland of international importance ‘under the Ramsar Convention on wetlands. The reserve serves as a crucial biodiversity hotspot with 21% of the Emirate's terrestrial animal and plant species, including globally

and nationally threatened species (Soorae et al., 2019).

Main Goals

1. Enhance the existing population of white saxaul in its native habitat.
2. Conserve and protect the ecological and cultural significance of the species.
3. Monitor and protect the species through habitat monitoring to ensure long-term protection of species.
4. Restore degraded habitats.

Success Indicators

1. Successful results of planting.
2. Expanding population in its native habitat.
3. Evidence of flowering and fruiting.

Project Summary

Feasibility

White saxaul is an endangered species in Abu Dhabi emirate with limited natural regeneration in its native habitat. In Abu Dhabi, the native population has been recorded from the Al Ghada Protected Area (AGPA) and AWWR. At AGPA, the current population was augmented through the planting of additional shrubs (Kabshawi et al., 2021). In AWWR, small stands of the species occur on sandy substrate in the southern and south-western parts of the reserve. This is probably its most eastern occurrence in the Arabian Peninsula, and so the stands are of biogeographical importance. Since the species has been in severe decline, several in situ conservation action has been in place to save the species from decline.

Implementation

To supplement the natural population, saplings were obtained from the native plant



Planted white saxaul in the AWWR
© Sabitha Sakkir

nursery. These saplings were developed from plant cuttings sourced from native plant population to prevent genetic variations. The saplings were of 20 - 30 cm tall. Planting pits with a depth of 30 cm were dug in the sand sheet and placed the plants in the pits in the sand sheets. Planting was carried out during the month of December when the temperature drops to 25° C during the day. Around 50 seedlings were planted within the protected areas, with each plant receiving drip irrigation to ensure optimal establishment and growth. Steps were taken to ensure the salinity of the soil is also optimal for the establishment of roots. Planting locations were recorded with GPS and mapped for long term monitoring purposes.

Post-planting Monitoring

All planted seedlings were assigned identification numbers and monitored according to a systematic protocol. For the first 6 months, monitoring was conducted monthly, with plant height and diameter recorded for each plant. After 6 months, monitoring shifted to a quarterly schedule, during which height and diameter were measured, and plants were assessed for evidence of flowering and fruiting. The number of surviving seedlings was documented at each monitoring interval to analyse survival trends over time.

Additionally, plants were examined for signs of pest infestation and nutrient deficiencies, and all observations were recorded. The monitoring will continue in the following years to ensure that the population reinforcement is successful and leads to the establishment of viable populations.

Major Difficulties Faced

Biological

Climate change: High temperatures and drought during the summer months can hinder growth.

Soil salinity: High salinity can also hinder the growth of some seedlings.

Major Lessons Learned

- Population reinforcement proved be a successful conservation strategy for the long-term conservation of endangered species belongs to the same family.
- Since extreme temperature could increase plant mortality, the seedlings could be watered in extreme conditions.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- More than 80% of the plants planted under the optimal environmental conditions have survived, and many of them have flowered and produced fruits.
- Reintroduction were carried out during winter months, when the temperature is optimal to ensure the establishment of seedlings.
- Drip irrigation during the first 6 months of plantation.

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Author Details

* *Sabitha Sakkir, Section Head, Plant Genetic Resources Centre (PGRC), Environment Agency - Abu Dhabi (EAD), PO Box 45553, Abu Dhabi, UAE, ssakkir@ead.gov.ae*

Jamal Al Zaidaneen, Director, PGRC, EAD, jamal.alzaidaneen@ead.gov.ae



Mitigation Translocation of Campo Rupestre on Canga Edaphic Endemic species in Carajás Mining Province, Pará, Brazil

Msc. Fernando Marino Gomes dos Santos [1,3*], Tais Nogueira Fernandes[1], Daniela Faria Scherer[1], Mariana Valentina Wardil[2], Samir Gonçalves Rolim[2] & Fernando Augusto Oliveira Silveira[3]

Introduction

The Carajás Mineral Province in Southeastern Amazon, Brazil, holds significant iron ore reserves and includes the Carajás National Forest, created to balance mining with conservation. The region is known for its unique ironstone outcrops that support a highly endemic flora with 38 species found nowhere else. We selected the top 10 species more threatened with extension of occurrence (EOO) smaller than 200 km^2 (*Carajasia cangae, Parapiqueria cavalcantei, Paspalum cangarum, Paspalum carajasense, Axonopus carajasensis, Ipomoea cavalcantei, Bulbostylis cangae, Daphnopsis filipedunculata, Ruellia anamariae* and *Lepidaploa paraensis*).

The practice of 'mitigation translocation' - moving organisms from areas facing habitat loss to alternative sites - is becoming common, though often controversial, if not applied following international best practice (Doyle et al, 2023). Permission for these development operations is often conditional on an obligation to mitigate or offset the impacts of the development. This is then claimed to be met by the translocation of individuals of key species from the site to be developed for release into further 'wild' sites (IUCN, 2013).

Unlike countries such as Canada, the USA, Australia, England, and France, which have established protocols for such translocations, Brazil lacks comprehensive guidelines, relying instead on ad hoc environmental agency reports. This gap highlights the need for defined best practices in conservation efforts in regions impacted by significant industrial activities.

Main Goals

1. To run translocation experiments in 10 edaphic specialists from Carajás Campo Rupestre on Canga Vegetation.
2. To develop translocation protocols using different techniques and propagules sources.
3. To develop effective practices to mitigate mining operations on endemic species and its habitat, secure the continuity of operations.



Overview of translocation site

Success Indicators

1. Demographic and genetic monitoring of translocated individuals and populations over time.
2. Reproduction (flowering, fruiting) intensity and recruitment in translocated individuals.
3. Establishment of new populations of the target species using different propagules sources (seeds, seedlings, vegetative adults).

Project Summary

Feasibility

Target species selection considered priority for the experiments: rare, endangered, and endemic species to the Campo rupestre on canga of the Carajas National Forest. All species are under threat from mining, the leading conservation risk caused by habitat loss. Additionally, species of conservation interest that may interfere with or impede the environmental licensing process were classified as priority (Giulietti et al., 2019) provided knowledge on seed ecology is available (Zanetti et al., 2020).

The recipient sites were defined based on similarities with natural populations and recipient sites obtained from vegetation mapping, loggers data interpretation and team expertise on surveying species in the region (Amplo, 2018).

Implementation

The project was divided in two cycles of experiments, where the first cycle experiments (2019 - 2020) involved microhabitat monitoring using data-loggers, rescues from natural areas, and transplantation to Vale's nursery. The experiments were conduct with 40 individuals, for each species, where 20 were exposed to irrigation 2-times a week and 20 individuals and monitoring in the nursery due to the time of the year where license was approved. In the second cycle (2020 - 2021), activities included selecting destination sites, indirectly translocating after 12 months in the nursery, directly transferring to the recipient sites, and directly sowing seeds at those sites.





Mining site (left) and translocation site (right)

Post-planting Monitoring

During experiments on species translocation in the Carajás National Forest, initial nursery trials resulted in survival rates exceeding 50% for 5 of 8 species, with *Paspalum cangarum* thriving at over 90%. However, *Carajasia cangae* faced 100% mortality. Improved survival was noted with irrigation. In a second cycle, direct transplantation of adult plants saw over 80% survival for four species. Translocation involving seed sourcing showed promising recruitment for *Carajasia cangae* and *Parapiqueria cavalcantei*. The project was halted in June 2021 by ICMBio, citing legal restrictions against introducing non-native species into conservation units, necessitating a revaluation of translocation practices within the Carajás National forest's limits.

Major Difficulties Faced

Biological

Implementing all translocation experiments of species with different life histories and life forms, and phenologies before onset of the dry season.

Obtaining individuals, seeds and propagules in sufficient numbers to complete the experimental design from the authorised vegetation clearance areas.

Poor knowledge of the plant species propagation and stress physiology.

Operational

Logistics to run the long distances transport from source populations to translocated populations, including temporary storage at nursery.

Legislative

Obtaining the permit for transplantation at the end of the rainy season caused a delay in the translocation experiments.

Working with translocation mitigation inside a Protected area with no specific regulation setting the rules and protocols for its application.

Other

Environmental agency staff responsible for the project assessment has changed during the permit revalidation.



Ipomoea cavalcantei one of the threatened species

Broad Underlying Problems

- We had no time to face these problems because the experiments were removed a few months after its complete implementation.

Major Lessons Learned

- A multi-species project limits time devoted for each species experiments and its only viable with teams dedicated for each group of species.
- The mitigation translocation proposal should have followed the process of design and feasibility of global standards (IUCN, 2013; Doyle et al., 2023) with clear description of the decision to translocation.
- Need of clearer institutional alignments with environmental agencies, including basic protocols and definition of translocation areas within Pas.
- Irrigation and passage through nursery increased survival rates.
- Seed sourcing translocation techniques for annual species need rigorous criteria for seed collection and quality tests to guarantee success.
- Pilot experimental attempts are crucial to estimate costs, test variables, develop transplantation protocols and create more realistic programmes.
- Testing different transplantation techniques with the same species increases the chances of success.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Considering that the environmental agency ICMBio requested the removal of all experiments.

Reasons for Success/Failure

- Proposition of a multiple targeted project, with non-specific decision to translocate or indication of destination translocation sites before the experiment's execution might have trigged agencies decision for removal.
- Request of the environmental agency to remove all experiments after the implementation justified by a new interpretation that the translocated populations were considered non-indigenous species under the Brazilian Protected Units System Law (SNUC), despite translocated sites located in the same mountain Range.
- Failure to maintain communication with the Environmental Agencies managers about the translocation sites and results.

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Author Details

[1] Vale S.A., North Operations Environmental Studies and Licensing, Alameda Oscar Niemeyer 132, Vale do Sereno, Nova Lima, MG, Brazil, fernandomarinog@gmail.com

[2] Amplo Engenharia, R. Bernardo Guimarães, 245 - Funcionários, Belo Horizonte, MG, Brazil, valentinawardil@gmail.com

[3] Centre for Ecological Synthesis and Conservation, Universidade Federal de Minas Gerais - UFMG, Av. Pres. Antônio Carlos, 6627 - Pampulha, Belo Horizonte Minas Gerais, Brazil, faosilveira@gmail.com



Application of circum-situ technique for Astragalus berytheus in Lebanon

Magda Bou Dagher[1]* & Rhea Kahale[1,2]

Introduction

Astragalus berytheus is a species endemic to Lebanon and areas to the south. It is considered as one of the most threatened taxa of Lebanon. The taxon occurs in prime tourist areas, such as sandy beaches, which are frequently targeted by developers for the establishment of tourist resorts. In fact, these habitats have already been classified as highly threatened because of extensive tourism activities throughout the Mediterranean region.

Historically, *Astragalus berytheus* was found in 5 locations in Lebanon. Four out of these 5 populations (Beirut, Ouzai, Bir Hassan and Khaldeh) were recently destroyed. The coastal strip was severely damaged by the construction of the highway connecting Beirut to the South in 1997 and the construction of the Beirut airport as well.

Main Goals

1. Conservation of the last remaining population of *A. berytheus*.
2. Creation of a new population where threats on species are minimized.
3. Increase the genetic diversity of the Lebanese population.

Success Indicators

1. Survival rate.
2. Flowering percentage.
3. Fruiting percentage.
4. Population abundance.
5. Resilience (genetic diversity).
6. Persistence (self-sustainability of the population).

Project Summary

Feasibility

The circum-situ conservation scheme aims to safeguard endemic and threatened species within archaeological sites that share the same bioclimatic conditions as their natural habitats. Since archaeological sites are already designated as protected areas, the risks to these species are significantly reduced. Furthermore, *A. berytheus* is a herbaceous plant with a shallow root system, ensuring that it poses no threat to the structural integrity of the ruins. Importantly, the selection of introduction sites was carried out in close coordination with site managers and the Directorate General of Antiquities in Lebanon.

Implementation

The translocations were implemented through different genetic materials:

a. Seedlings germinated beforehand in Jouzour Loubnan seed bank.

b. Seeds collected from the last remaining population in Tyre coast Nature Reserve.

A total number of 20 seedlings were translocated, and 200 via seeds, were introduced onto the site.

Post-planting Monitoring

We are applying seasonal monitoring, where the survival rate and flowering and fruiting percentage are being recorded. Taking into account different criteria such as the survival rate, age of the genetic material and its origins, it could be noted that seedlings have more probability of survival than seeds.

Major Difficulties Faced

Biological

Climate: Endemic species like *Astragalus* are most vulnerable to climate change, as they hold limiting intrinsic factors, leading to a relatively small distributional range.



Astragalus berytheus habitat

Anthropogenic: Human activity is limited to some illegal trespassing within the archeological site. However, since the site is protected, this factor is considered a secondary threat.

Other

Economic: Funding for the project.

Broad Underlying Problems

- *Alien species: Astragalus berytheus* is threatened by an invasive species *Heterotheca subaxillaris*. This species is finding optimal conditions for growth in the natural habitat of *A. berytheus* in Tyre Coast Nature Reserve and therefore consuming all the space and resources.

Major Lessons Learned

- Age and form of genetic material to introduce.
- Seedlings have more probability to survival than seeds.
- Site pre- and post-maintenance is crucial for the survival of the species.
- Seasonal monitoring and evaluating the population.

- An essential component of the project is communicating the importance of plant conservation to diverse stakeholders. In particular, it was necessary to engage with the Directorate General of Antiquities, which oversees archaeological sites in Lebanon, to secure their support for this innovative approach of conserving endemic and threatened species within these sites. Additionally, close collaboration with site managers was required to address the logistical aspects of reintroduction, including the identification of suitable areas and the preparation of sites both prior to and following planting.
- Furthermore, we collaborated closely with the site's committee to integrate species management into the overall management plan and to develop effective strategies for conserving these species within the protected areas.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- The active involvement of stakeholders stands as a pivotal success factor in the conservation of *Astragalus* species by protecting their habitat as a natural site creating a new population in an already protected archeological site. This collaboration brings together diverse perspectives, expertise, and resources, amplifying the effectiveness and sustainability of conservation efforts.
- *Holistic approach:* Stakeholders include governments, local communities, conservation organizations, researchers, and the directorate General of Antiquities. Their collective input ensures a comprehensive understanding of the challenges and opportunities related to the species habitat conservation. This holistic approach leads to well-informed strategies that consider ecological, social, and economic dimensions.
- *Shared responsibility:* Stakeholder involvement fosters a sense of shared responsibility for the irises and their habitat. This shared ownership enhances commitment and dedication to long-term conservation goals, reducing the burden on any single entity and encouraging sustained efforts.
- *Tailored solutions:* Each stakeholder group brings unique expertise and perspectives to the table. Collaborative efforts enable the development of solutions that are tailored to the specific challenges of Astragalus conservation, optimizing the likelihood of success.

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Not available.

Author Details

[1] Université Saint-Joseph, Beirut, Lebanon,* magda.boudagher@usj.edu.lb

[2] Jouzour Loubnan Association, Beirut, Lebanon, rhea.kahale@net.usj.edu.lb



Application of circum-situ technique for Iris antilibanotica in Lebanon

Magda Bou Dagher[1]* & Rhea Kahale[1,2]

Introduction

Iris antilibanotica is considered to be endemic to a small area of the Anti-Lebanon Mountains and was considered extinct at some point. Fortunately, one last remaining population was found in the backyard of a private land in Khraybet Ballabeck, eastern Lebanon. The species is listed as Critically Endangered in the IUCN Red List.

Grazing is suspected to be the major threat in the known locality of the species. Impacts from agricultural activities are also apparent. The area in which the species occurs is also threatened by development and conversion of natural habitats to agricultural along with the secondary effects of the ongoing civil war in a neighbouring country.

Main Goals

1. Conservation on the endemic and threatened species in situ.
2. Creation of a new population where threats on species are minimized.
3. Increase the genetic diversity of the Lebanese population.

Success Indicators

1. Survival rate.
2. Plant height.
3. Flowering percentage.
4. Fruiting percentage.
5. Population abundance.
6. Resilience (genetic diversity).
7. Persistence (self-sustainability of the population).

Project Summary

Feasibility

The circum-situ conservation scheme aims to safeguard endemic and threatened species within archaeological sites that share the same bioclimatic conditions as their natural habitats. Since archaeological sites are already designated as protected areas, the risks to these species are significantly reduced. Furthermore, *I. antilibanotica* is a herbaceous plant with a shallow root system, ensuring that it poses no threat to the structural integrity of the ruins. Importantly, the selection of introduction sites was carried out in close coordination with site managers and the Directorate General of Antiquities in Lebanon.



Working at the field site with local communities

Implementation

Many translocations were implemented through different genetic materials:

a. Seedlings germinated beforehand in Jouzour Loubnan seed bank.

b. Seeds collected from the last remaining population in Khraybet Baalback.

c. Rhizomes of *Iris antilibanotica* individuals, taken directly from site and translocated onto the archeological site.

A total number of 114 seedlings, 100 seeds and 103 rhizomes were introduced onto the site.

Post-planting Monitoring

We are implementing seasonal monitoring to record survival rates, as well as flowering and fruiting percentages. Based on various criteria, including survival rate, the age of the genetic material, and its origin, It has been observed that seedlings demonstrate a higher probability of survival compared to seeds.

Major Difficulties Faced

Biological

Climate: Endemic species like Irises are most vulnerable to climate change, as they hold limiting intrinsic factors, leading to a relatively small distributional range.

Anthropogenic: Human activity is limited to some illegal trespassing within the archeological site. However, since the site is protected, this factor is considered a secondary threat.

Genetic: Iris species have a limited and short-distance dispersal capability. This makes the distribution of its population scattered and limited to a narrow altitudinal belt. As a result, it is unlikely to be able to track the rate of ecological change, inbreeding depression which is leading to a genetic bottleneck. The species is therefore vulnerable and unable to resist devastating threats.

Broad Underlying Problems

- Effects of climate change.

Major Lessons Learned

- An essential component of the project is communicating the importance of plant conservation to diverse stakeholders. In particular, it was necessary to engage with the Directorate General of Antiquities, which oversees archaeological sites in Lebanon, to secure their support for this innovative approach of conserving endemic and threatened species within these sites. Additionally, close collaboration with site managers was required to address the logistical aspects of reintroduction, including the identification of suitable areas and the preparation of sites both prior to and following planting.
- Furthermore, we collaborated closely with the site's committee to integrate species management into the overall management plan and to develop effective strategies for conserving these species within the protected areas.
- Success factors for introduction:
    - Seedlings should be mature enough for reintroduction.
    - Pre- and post-reintroduction planning are necessary for a successful operation.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure
■			

Reasons for Success/Failure

- The active involvement of stakeholders stands as a pivotal success factor in the conservation of iris species by protecting their habitat as a natural site creating a new population in an already protected archeological site. This collaboration brings together diverse perspectives, expertise, and resources, amplifying the effectiveness and sustainability of conservation efforts
- *Holistic approach:* Stakeholders include governments, local communities, conservation organizations, researchers, and the directorate General of Antiquities. Their collective input ensures a comprehensive understanding of the challenges and opportunities related to iris habitat conservation. This holistic approach leads to well-informed strategies that consider ecological, social, and economic dimensions.
- *Shared responsibility:* Stakeholder involvement fosters a sense of shared responsibility for the irises and their habitat. This shared ownership enhances commitment and dedication to long-term conservation goals, reducing the burden on any single entity and encouraging sustained efforts.
- *Tailored solutions:* Each stakeholder group brings unique expertise and perspectives to the table. Collaborative efforts enable the development of solutions that are tailored to the specific challenges of iris conservation, optimizing the likelihood of success.

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Not available.

Author Details

[1*] *Université Saint-Joseph, Beirut, Lebanon,* magda.boudagher@usj.edu.lb

[2] *Jouzour Loubnan Association, Beirut, Lebanon,* rhea.kahale@net.usj.edu.lb



Translocation and reinforcement of Iris sofarana in Lebanon

Magda Bou Dagher[1]* & Rhea Kahale[1,2]

Introduction

Iris sofarana forma *kasruwana* is considered endemic to the western slopes of Mount Lebanon. The species is listed as Endangered of the IUCN Red List. The different spots where the species occur are all located on the western slopes of Mount Lebanon. Due to its altitudinal range, the species has many potential threats amongst which are urban development for housing and recreational activities (ski resort and chalets) are the most important ones in the northern parts of its distribution.

Grazing does seem to be a threat and collection of flowers by locals impacts all populations. Sand quarrying is the most extensive threat in the southern part of the plants distribution, where land reclamation for agriculture and orchards is also increasing.

Main Goals

1. Conservation on the endemic and threatened species in situ.
2. Creation of a new population where threats on the species are minimized.
3. Increase the genetic diversity of the Lebanese population.

Success Indicators

1. Survival rate of the plants.
2. Plant height.
3. Flowering percentage.
4. Fruiting percentage.
5. Population abundance.
6. Resilience (genetic diversity).
7. Persistence (self-sustainability of the

population).

Project Summary

Feasibility

The area in El Dichar where the species occurs was designated as a Natural Site (Decree No. 2878) in 2015 to protect *Iris sofarana* in Ehmej. This designation followed research supported by a grant from the Critical Ecosystem Partnership Fund awarded to Saint Joseph University. Since some *Iris sofarana* individuals are located on private lands adjacent to the El Dichar Natural Site, rhizome translocation has been carried out in cases of imminent habitat destruction. Additionally, seeds are collected annually for ex situ conservation, including seed banking and population reinforcement within the protected area.

Implementation

Many translocations were implemented through different genetic materials:

- 67 rhizomes were translocated from one source population that was threatened with habitat destruction into El Dichar Natural site.
- A total number of 114 seedlings, 100 seeds and 67 rhizomes were introduced onto the site.

Post-planting Monitoring

We are implementing seasonal monitoring to record survival rates, as well as flowering and fruiting percentages.

Major Difficulties Faced

Biological

Climate: Endemic species like Irises are most vulnerable to climate change, as they hold limiting intrinsic factors, leading to a relatively small distributional range.

Anthropogenic: Human activity is limited to some illegal trespassing within natural site.



Close up of Iris sorofana

However, since the site is protected, this factor is considered a secondary threat.

Genetic: Iris species have a limited and short-distance dispersal capability. This makes the distribution of its population scattered and limited to a narrow altitudinal belt. As a result, it is unlikely to be able to track the rate of ecological change, inbreeding depression which is leading to a genetic bottleneck. The species is therefore vulnerable and unable to resist devastating threats.

Other

Economic: Funding for the project.

Broad Underlying Problems

- Effects of climate change.

Major Lessons Learned

- The primary lesson learned from this experience revolves around safeguarding

natural habitats to ensure the preservation of delicate species like irises. It is evident that by nurturing and conserving the habitat as a pristine natural site, we can effectively shield the irises from potential threats and disruptions. This crucial lesson emphasizes the symbiotic relationship between species and their habitats, highlighting the significance of proactive conservation efforts.

- This case highlights that effective species conservation requires tailored approaches based on the species' biology, land ownership, and specific threats. For *Iris sofarana*, the combination of rhizome translocation and the establishment of a new protected area proved essential to safeguard the population. The lesson learned is that conservation strategies must be flexible and adapted to each species' context, with a combination of in situ protection, habitat management, and ex situ measures applied as appropriate.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Reasons for Success/Failure

- The active involvement of stakeholders stands as a pivotal success factor in the conservation of iris species by protecting their habitat as a natural site. This collaboration brings together diverse perspectives, expertise, and resources, amplifying the effectiveness and sustainability of conservation efforts

- *Holistic approach:* Stakeholders include governments, local communities, conservation organizations, researchers, and more. Their collective input ensures a comprehensive understanding of the challenges and opportunities related to iris habitat conservation. This holistic approach leads to well-informed strategies that consider ecological, social, and economic dimensions.

- *Shared responsibility:* Stakeholder involvement fosters a sense of shared responsibility for the irises and their habitat. This shared ownership enhances commitment and dedication to long-term conservation goals, reducing the burden on any single entity and encouraging sustained efforts.

- *Tailored solutions:* Each stakeholder group brings unique expertise and perspectives to the table. Collaborative efforts enable the development of solutions that are tailored to the specific challenges of iris conservation, optimizing the likelihood of success.

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Not available.

Author Details

[1] Université Saint-Joseph, Beirut, Lebanon,* magda.boudagher@usj.edu.lb

[2] Jouzour Loubnan Association, Beirut, Lebanon, rhea.kahale@net.usj.edu.lb



Reintroduction after a megafire: the case of the endemic Corsican peony in the Montiferru Massif, CW Sardinia, Italy

Giuseppe Fenu[1]*, Giulia Calderisi[2] & Donatella Cogoni[3]

Introduction

Paeonia corsica Sieber ex Tausch is a rhizomatous geophyte endemic to Sardinia and Corsica. In Sardinia it thrives above 600 m a.s.l. on diverse geological substrates, preferring deep, humus-rich, and well-drained soils. This species participates in various habitats, including woodlands, riparian environments, and mountain open scrub, often alongside endemic plants. Sardinian populations are stable, and the species has an IUCN status of Least Concern (LC) at the regional level (Orsenigo et al., 2021). Currently this plant is not listed in any protection regulations.

A significant population of peony thrives on Mt. Montiferru, a Plio-Pleistocenic volcanic massif with a peak of 1,050 m, characterised by sclerophyllous forest dominated by holm and mixed deciduous oak forests; moreover, a vast territory was reforested with different species of conifers. In 2021, a megafire devastated over 12,000 ha of this area (Rossetti et al., 2022).

Main Goals

1. To reintroduce this endemic plant species into an area severely affected by a megafire.
2. To increase the population size, and specifically, to boost the number of mature individuals.
3. To increase the probability of population survival and the reproductive rate.
4. To promote the natural recovery of this area after the megafire.
5. To obtain useful information for a successful translocation of the endemic *Paeonia corsica*.

Success Indicators

1. Long-term survival rate of transplanted individuals.
2. Flowering and fruiting rates of the transplanted individuals.
3. Number of newly established seedlings.
4. Number of recruited seedlings becoming reproductive (from the 5th year).
5. The effectiveness of the management action (protective fence).



Hoed operations to improve aeration of the soil © G. Fenu

Project Summary

Feasibility

In the Montiferru massif, *Paeonia corsica* mainly found in holm oak forests. Although this endemic species is not regionally threatened, the megafire that occurred in 2021 severely impacted its population in the massif. The fire caused particularly devastating effects in the upper areas of the massif, where holm oak forests, along with dense heather groves consisting of *Erica arborea* L. and *Arbutus unedo* L., suffered extensive damage. This destruction was observed across lands managed by public authorities as well as privately owned areas, highlighting the widespread impact of the event on both natural habitats and land management systems.

Implementation

The reintroduction was carried out in suitable sites near the natural population, where megafire effects were less serious. The activities, implemented on a private land through an agreement with the owner, started in September 2021. Damaged plants by fire or wild boars were explanted and kept in pots in a mountain stable. Twenty additional plants were eradicated from a dense local population. In December 2021, 47 adult plants were transplanted into large holes with humus-rich soil taken from unburned areas and sand to avoid soil compaction. Each transplanted plant was protected with stones and labelled for following monitoring activities.

Post-planting Monitoring

No significant post-planting interventions were carried out; however, the pre-existing fence was restored to prevent the grazing and trampling by wild animals. During the first months, the substrate around the plants was hoed to improve aeration of the soil. Water was only given to the plants once, right after the transplant. After 3 years, the monitoring results showed that a large percentage of transplanted individuals had survived (>95%). Moreover, starting in June 2022, some individuals began flowering and fruiting, with 54% of the total transplanted individuals producing flowers and fruit by the 3rd year.

Major Difficulties Faced

Biological

Ecological: Grazing and trampling of wild animal limitation, important population of ungulates has not abandoned the burned area.

Climate: Drought results in arid summers and is a critical factor for plant persistence, in particular during the first years.

Environmental: Suitable site selection due to the severe impact of the megafire, made it difficult to identify suitable sites for transplantation.

Environmental: Promote general habitat restoration to ensure the long-term survival of transplanted plants.

Broad Underlying Problems

- *Climate change:* The Montiferru massif had already been affected by several megafires in the past but an increase in fires frequency and severity is expected as a consequence of the climate change.

Major Lessons Learned

- As previously reported (Fenu et al., 2023), conservation actions can also be carried out on private land with the collaboration of the owners.
- Farmers' field experience provides a significant contribution in the implementation of a translocation (e.g., selection of suitable sites, transplantation techniques, etc.).
- Participatory processes (landowner involvement) promote acceptance of conservation actions.
- Effective translocations can be achieved at low cost by leveraging local resources and involving enthusiast farmers.
- Species-specific translocation protocols are needed. It is necessary to test different approaches and select the best one, which is cost-effective, feasible, and guarantees high success.
- Species-specific and site-specific management actions are necessary to increase the likelihood of a successful translocation.
- Plants collected and cultivated in proximity to the translocation site appear to be more easily adaptable to local ecological conditions.
- Time and long-term monitoring are needed in order to have a clear figure of the success of any in situ action.

Success or Failure of Project

Highly Successful	Successful	Partially Successful	Failure

Long-term survival rate of transplanted individuals: successful.
Flowering and fruiting rates of the transplanted individuals: successful.
Number of newly established seedlings: too early.
Number of recruited seedlings becoming reproductive: too early.
Effectiveness of protective fence to prevent damage to the transplants: successful.

Reasons for Success/Failure

- Active involvement of farmers in all stages of the translocation (decision-making, operational, post-intervention, etc.).
- Identification of ecologically suitable transplant sites.
- Great experience of farmers in managing field operations.
- Availability of reproductive plants near the translocation site.
- Identification of appropriate post-release management actions.
- Continuous monitoring ensures the effectiveness of the actions.

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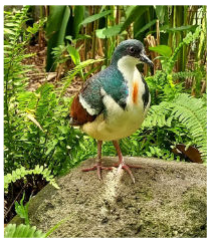
Author Details

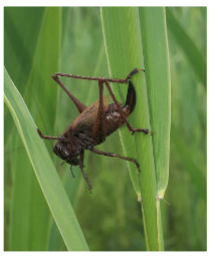
[1] Department of Life and Environmental Sciences, University of Cagliari, Viale Sant'Ignazio da Laconi 13,09123 Cagliari, Italy, gfenu@unica.it*

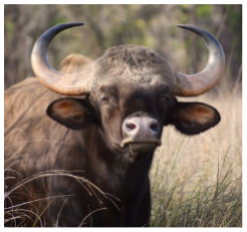
[2] Giulia Calderisi, giulia.calderisi@unica.it

[3] Donatella Cogoni, d.cogoni@unica.it







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